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MATHEMATICS—*Inequalities restricting the form of the stress-deformation relations for isotropic elastic solids and Reiner-Rivlin fluids.* M. BAKER and J. L. ERICKSEN, Naval Research Laboratory. (Communicated by Horace M. Trent.)

According to the natural state theory of elasticity, the principal values t_1, t_2, t_3 of the stress tensor for an isotropic, perfectly elastic material are given in terms of the principal extensions δ_1, δ_2, δ_3 by[1]

$$t_i = \frac{2\rho}{\rho_0}\left[\left(II\frac{\partial\Sigma}{\partial II} + III\frac{\partial\Sigma}{\partial III}\right) + \frac{\partial\Sigma}{\partial I}(1+\delta_i)^2 - III\frac{\partial\Sigma}{\partial II}\frac{1}{(1+\delta_i)^2}\right], \quad (1)$$

if the material is compressible, and by

$$t_i = -p + 2\frac{\partial\Sigma}{\partial I}(1+\delta_i)^2 - 2\frac{\partial\Sigma}{\partial II}\frac{1}{(1+\delta_i)^2}, \quad (2)$$

if the material is incompressible. Here, Σ the strain energy, is a function of $I \equiv (1+\delta_1)^2 + (1+\delta_2)^2 + (1+\delta_3)^2$, $II \equiv (1+\delta_1)^2(1+\delta_2)^2 + (1+\delta_3)^2(1+\delta_1)^2 + (1+\delta_2)^2(1+\delta_3)^2$ and $III \equiv (1+\delta_1)^2(1+\delta_2)^2(1+\delta_3)^2$, p is an arbitrary hydrostatic pressure, ρ is the density in the deformed state, and ρ_0 the density in the undeformed state. The condition for incompressibility is $III = 1$ so that $\Sigma = \Sigma(I, II)$ in (2).

Truesdell[2] has given a physical argument which shows that, for an incompressible material, the inequalities

$$(1+\delta_i)^2\frac{\partial\Sigma}{\partial II} + \frac{\partial\Sigma}{\partial I} > 0 \quad (3)$$

should always be satisfied. Rivlin[3] derived a special case of this inequality and used it to obtain qualitative information about the Poynting effect. These inequalities also gave information concerning the propagation of waves in such materials.[4]

By considering general isotropic functions, we shall deduce certain inequalities which follow from conditions imposed on the eigenvalues of the tensors involved. We shall then discuss the significance of these conditions as applied to elastic solids and viscous fluids, and determine the form which these inequalities assume in the different physical situations. In particular, we shall see that inequality (3) should hold for both incompressible and compressible materials.

Suppose that the 3×3 real symmetric matrix $\mathbf{A}$ is an isotropic analytic function of the 3×3 real symmetric matrix $\mathbf{B}$. We then have[5]

$$\mathbf{A} = f_0\mathbf{1} + f_1\mathbf{B} + f_2\mathbf{B}^2, \quad (4)$$

where the scalars f_j are functions of the three principal invariants of $\mathbf{B}$.

Now, if $\mathbf{B}^{-1}$ exists, we can also write $\mathbf{A}$ in the form

$$\mathbf{A} = g_0\mathbf{1} + g_{-1}\mathbf{B}^{-1} + g_1\mathbf{B}, \quad (5)$$

where the scalars g_i are also functions of the three principal invariants of $\mathbf{B}$. Equation (4)

[1] See, e.g., TRUESDELL, C. A., *The mechanical foundations of elasticity and fluid dynamics*, Journ. Ratl. Mech. and Anal. **1**: 173–182. 1952.

[2] TRUESDELL, C. A., op. cit.: 181–182.

[3] RIVLIN, R. S., and SAUNDERS, D. W., *Large elastic deformations of isotropic materials VII. Experiments on the deformation of rubber*, Phil. Trans. Roy. Soc. London (A) **243**: 251–288. 1951.

[4] ERICKSEN, J. L., *On the propagation of waves in isotropic, perfectly elastic materials*, Journ. Ratl. Mech. and Anal. **2**: 329–337. 1953.

[5] TRUESDELL, C. A., op. cit.: 131–132.

implies that the eigenvalues a_1, a_2, a_3 of **A** are related to the eigenvalues b_1, b_2, b_3 of **B** by

$$a_i = f_0 + f_1 b_i + f_2 b_i^2, \tag{6}$$

while (5) yields

$$a_i = g_0 + g_{-1}/b_i + g_1 b_i. \tag{7}$$

We want to determine necessary and sufficient conditions that the inequality $a_i > a_j$ hold whenever $b_i > b_j$. Let us first consider (6), which yields

$$a_i - a_j = (b_i - b_j)[f_1 + f_2(b_i + b_j)].$$

Thus a necessary and sufficient condition that $b_i > b_j$ imply $a_i > a_j$ is that

$$f_1 + f_2(b_i + b_j) > 0, \tag{8}$$

whenever $b_i > b_j$. Since (8) is unaltered if b_i and b_j are interchanged, this inequality must hold unless $b_i = b_j$ $(i \neq j)$, in which case (8) is replaced by the weaker inequality $f_1 + f_2(b_i + b_j) = f_1 + 2f_2 b_i \geq 0$. This latter condition follows from the fact that **A** is a continuous function of **B**. Similarly, from (7), we obtain, as an alternative necessary and sufficient condition,

$$g_1 > g_{-1}/b_i b_j, \tag{9}$$

unless $b_i = b_j$, and $g_1 \geq g_{-1}/b_i b_j = g_{-1}/(b_i)^2$ if $b_i = b_j$ $(i \neq j)$.

Let **T** denote the stress tensor in a continuous medium. At any point P, each of the three perpendicular planes whose normal vectors are eigenvectors of **T** has the property that the stress vector acting on it at P is normal to it. These normal forces (per unit area) are the eigenvalues t_1, t_2, t_3 of **T**. A positive eigenvalue corresponds to a tension, a negative eigenvalue to a pressure. We assume the eigenvalues ordered so that $t_1 \geq t_2 \geq t_3$.

In an isotropic, perfectly elastic body, the principal directions of **T** coincide with the directions of principal extension. We restrict our attention to these directions. For such a material, it is reasonable to suppose that the greatest (least) tension occurs in the direction corresponding to the greatest (least) extension. Expressing these conditions analytically, we obtain

$$t_i > t_j \text{ whenever } \delta_i > \delta_j. \tag{10}$$

It may be possible to get further conditions by comparing forces and extensions in other directions. One might, for example, compare normal stresses and extensions normal to an arbitrary pair of perpendicular planes. However, because of the fact that a pure shearing stress acting on a plane may give rise to extensions normal to this plane, the validity of results obtained from such a comparison is questionable. Comparing (1) and (7), we see that (10) implies (9) with $b_i = (1 + \delta_i)^2$, $g_1 = 2(\rho/\rho_0)\,\partial\Sigma/\partial I$, $g_{-1} = -2(\rho/\rho_0)\,III\,\partial\Sigma/\partial II$. Since $\rho/\rho_0 > 0$, we have for $i \neq j$,

$$\left.\begin{aligned} \frac{\partial\Sigma}{\partial I} + \frac{III}{(1+\delta_i)^2(1+\delta_j)^2}\frac{\partial\Sigma}{\partial II} > 0 \quad &\text{if } \delta_i \neq \delta_j, \\ \frac{\partial\Sigma}{\partial I} + \frac{III}{(1+\delta_i)^2(1+\delta_j)^2}\frac{\partial\Sigma}{\partial II} \geq 0 \quad &\text{if } \delta_i = \delta_j, \end{aligned}\right\} \tag{11}$$

for a compressible material. Since $III = (1 + \delta_1)^2(1 + \delta_2)^2(1 + \delta_3)^2$, the inequalities (11) become

$$\left.\begin{aligned} \frac{\partial\Sigma}{\partial I} + (1+\delta_i)^2\frac{\partial\Sigma}{\partial II} > 0 \\ \text{if } \delta_j \neq \delta_k \ (i, j, k \neq), \\ \frac{\partial\Sigma}{\partial I} + (1+\delta_i)^2\frac{\partial\Sigma}{\partial II} \geq 0 \\ \text{if } \delta_j = \delta_k \ (i, j, k \neq). \end{aligned}\right\} \tag{12}$$

Comparing (7) with (2), we see that (10) implies (9) with $b_i = (1 + \delta_i)^2$, $g_1 = 2\partial\Sigma/\partial I$, $g_{-1} = -2\partial\Sigma/\partial II$. Using the incompressibility condition $III = 1$, one can show that the resulting inequality reduces to (12), which is in agreement with Truesdell's result (3). Results of a number of experiments on rubber,[6] which is virtually incompressible, show that $\partial\Sigma/\partial I > 0$, $\partial\Sigma/\partial II > 0$ for a wide range of values of I and II so that (12) certainly holds in this case.

Now, in the classical linear theory of elasticity, the stress tensor **T** is given in

[6] RIVLIN, R. S., and SAUNDERS, D. W., op. cit.

terms of the infinitesimal strain tensor $\mathbf{E}$ by $\mathbf{T} = \lambda\,\mathbf{1} + 2\mu\mathbf{E}$, where λ and μ are the Lamé constants. Application of the above analysis to this expression for $\mathbf{T}$ leads immediately to the condition $\mu > 0$, which is certainly true for all materials which are adequately described by this theory.

According to the theory of compressible, highly viscous fluids proposed by Reiner,[7] the stress $\mathbf{T}$ is an analytic isotropic function of the rate of deformation $\mathbf{D}$, so that

$$\mathbf{T} = f_0\mathbf{1} + f_1\mathbf{D} + f_2\mathbf{D}^2, \tag{13}$$

where the scalars f_i are functions of the three principal invariants of $\mathbf{D}$. In terms of the eigenvalues d_1, d_2, and d_3 of $\mathbf{D}$, these invariants are $d_1 + d_2 + d_3$, $d_1d_2 + d_2d_3 + d_3d_1$, and $d_1d_2d_3$. Rivlin's theory[8] differs from this only in that $\mathbf{D}$ is assumed to satisfy the condition of incompressibility, $d_1 + d_2 + d_3 = 0$, and $-f_0$ is replaced by an arbitrary hydrostatic pressure p. That is,

$$\mathbf{T} = -p\mathbf{1} + f_1\mathbf{D} + f_2\mathbf{D}^2. \tag{14}$$

At a given point P at a given time, the rate of increase of distance between the material particle at P and particles lying on a sphere of fixed radius r about P will take on stationary values for certain particles on this sphere. The directions determined by drawing the radius vector from P to these particles approach the principal directions of $\mathbf{D}$ as r tends to zero. In first approximation, the stationary values mentioned above are obtained by multiplying the appropriate eigenvalue of $\mathbf{D}$ by r. Let us restrict our attention to the principal directions of $\mathbf{D}$ which, in a Reiner-Rivlin fluid, are simultaneously principal directions of $\mathbf{T}$. It seems reasonable to suppose that, at a point P in such a material, the greatest (least) tension will be exerted across a plane whose normal is in the direction in which the rate of increase of distance between the particle at P and particles equidistant from P is greatest (least). That is, we should have

$$t_i > t_j \text{ whenever } d_i > d_j\,. \tag{15}$$

It then follows from (6), (8), and (13) that, for a compressible material,

$$\left.\begin{aligned} &f_1 + f_2(d_i + d_j) > 0 \quad \text{if } d_i \neq d_j\,, \\ &f_1 + f_2(d_i + d_j) \geqq 0 \quad \text{if } d_i = d_j\,(i \neq j). \end{aligned}\right\} \tag{16}$$

From (6), (8), and (14) it follows that (16) must also hold for incompressible materials. In this case one can, using the incompressibility condition $d_1 + d_2 + d_3 = 0$, write (16) as

$$\left.\begin{aligned} &f_1 - f_2d_i > 0 \qquad \text{if } d_j \neq d_k\,(i,j,k \neq), \\ &f_1 - f_2d_i \geqq 0 \qquad \text{if } d_j = d_k\,(i,j,k \neq). \end{aligned}\right\} \tag{17}$$

For a plane motion of an incompressible fluid, $d_2 = 0$ and $d_3 = -d_1$, so that (17) becomes

$$\left.\begin{aligned} &f_1 > 0, f_1 > f_2d_1\,, f_1 > -f_2d_1 \quad \text{if } d_1 \neq 0, \\ &f_1 \geqq 0 \qquad\qquad\qquad\qquad\quad \text{if } d_1 = 0. \end{aligned}\right\} \tag{18}$$

If $d_1 = 0$, then $d_2 = d_3 = 0$, so the motion is instantaneously rigid. From (18),

$$\left|\frac{f_1}{f_2d_1}\right| > 1, \tag{19}$$

except perhaps when $d_1 = 0$, in which case the ratio on the left may be indeterminate. It has been shown[9] that, in such a motion, the equation $f_1 + f_2d_1 \cos 2\varphi = 0$ determines two characteristic directions for the equations (14). According to (19), there exists no real angle φ for which this equation is satisfied.

In the classical theory of isotropic viscous fluids, $f_2 = 0$ and $f_1 = 2\mu$, where μ is the coefficient of viscosity. Since μ is always positive, (16) holds for materials to which this theory applies.

[7] REINER, M., *A mathematical theory of dilatancy*, Amer. Journ. Math. **65**: 350–362. 1945.

[8] RIVLIN, R. S., *Hydrodynamics of non-Newtonian fluids*, Nature **160**: 611–613. 1947.

[9] ERICKSEN, J. L., *Characteristic surfaces of the equations of motion for non-Newtonian fluids*, Zeitschr. für Angew. Math. u. Physik **4**: 260–267. 1953.

PALEONTOLOGY.—*The development of the hinge of* Veniella conradi (*Morton*) *and some conclusions based on its study.* H. E. VOKES, The Johns Hopkins University.

While studying Cox's excellent report on *Cretaceous and Eocene fossils from the Gold Coast* (1952) the writer's attention was struck by a statement (p. 19) made during his comparison of the hinge of *Veniella conradi* (Morton), the type species of *Veniella* Stoliczka (1870, p. 181), with that of "*V.*" *undata* (Conrad), the presently accepted name for the type species of *Roudairia* Munier-Chalmas (1881, p. 74). This statement may be paraphrased as follows: If good figures of the interior of the shell of *Veniella conradi* "are compared with those of the hinge of *V. undata* . . . it may be seen that hinge-structure of the right valve is essentially the same in the two species. In the left valve of *V. undata* the anterior lateral consists of two narrow, divergent prongs united at the top, whereas in the single satisfactory illustration of the left valve of *V. conradi* (that given by Stephenson [1923, p. 66, fig. 4]) the same tooth appears to be thicker and its bifid character is less obvious. The fine transverse crenulation of the posterior laterals of *V. conradi*, shown in Stephenson's figures, has not been observed in *V. undata*, but this may be due to imperfect preservation."

This suggestion of a difference in the left valves of the two species without a corresponding divergence in the right led me to examine the series of specimens of *V. conradi* in our collections, and especially those in the Wade collection from Coon Creek, Tenn. where the species is common and well-preserved. It was found that while the condition of the left anterior lateral in all the adult left valves agreed with that figured by Stephenson, in other respects the specimen figured was in a somewhat immature stage of development. On the other hand, certain "adolescent" individuals show some trace of bifidity of the anterior lateral, though never is this as pronounced as in the illustrations of "*V.*" *undata* given by Quaas (1902, pl. 34, fig. 22: as *Roudairia Drui*) and by Pervinquière (1912, pl. 15, fig. 11b). Furthermore, a comparison of right valves with those figured by Pervinquière (1912, pl. 15, fig. 12a), and by Rennie (1930, pl. 21, fig. 9; as *Veniella drui*), shows that there are differences in the anterior area of the hinge that correspond with those of the left valve.

Another fact that became apparent during the examination of these specimens was that there was a pronounced change in the nature and orientation of the anterior elements of the hinge structure during the development of the individual. An examination of the published literature indicates that this fact has not been noted by previous students, and since it may have some significance in elucidating the ancestry of the veniellid type, it seems desirable to record the observed facts at this time.

The hinge of the adult right valve has been well figured by Wade (1926, pl. 24, fig. 16), while illustrations and descriptions of somewhat less mature examples of this hinge have been given by Gardner (1916, pp. 643–5, pl. 38, fig. 4) and Stephenson (1923, pp. 257–62, pl. 66, fig. 5; 1941, pp. 168–70). Miss Gardner (1916, pl. 38, fig. 3) also figures, but without comment, the hinge of an immature right valve of somewhat unusual outline. Meek (1876, pp. 147–8, text figs. 9–11) refigured Morton's type specimen, a right valve, but misinterpreted the nature of the hinge. Douvillé (1921, p. 121, text fig. 16) gives a very diagrammatic drawing of a right valve from "la Craie superieure du Tennessee," presumably the Coon Creek locality.

The only adequate figure of a hinge of the left valve is that of the somewhat immature specimen furnished by Stephenson (1923, pl. 66. fig. 4).

DEVELOPMENT OF THE HINGE OF THE RIGHT VALVE

The smallest complete right valve available for study has a length of 7.6 mm and a height of 6.6 mm. There are two well-developed concentric lamellae on the exterior of the shell. A very similar specimen has a length of 8 mm and a height of 7 mm. From these minima a rather complete series of specimens up to adult valves has been studied. The largest valves are 61.5 mm long and 50.5 mm high; and 57 mm

long and 52.5 mm high, respectively. Fragments of valves smaller than the smallest mentioned above give suggestions as to earlier stages of the hinge development but are too incomplete to permit certain conclusions.

In the smallest complete specimens the hinge of the right valve (Fig. 1) consists of cardinals **3a** and **3b**. Tooth **3a** is long, relatively thin, and sub-parallel with the anterior dorsal margin of the valve. Its anterior end terminates at a point approximately midway across the narrow hinge plate. The posterior cardinal, **3b**, is oblique in position, subtriangular in shape, moderately heavy and weakly grooved; in adult specimens it is weakly bifid. The anterior end of the tooth is, in the smallest specimen, definitely continuous with the posterior end of **3a**, although the lamina from which these two teeth have been derived is greatly thinned and the connection is quite tenuous.

In addition to the two cardinals the hinge carries long, deep anterior and posterior lateral sockets, bordered on their ventral sides by relatively strong laminae, **AI** and **PI**, and with low, but sharp ridges on their dorsal sides marking the position of laminae **AIII** and **PIII**. The sides of both anterior and posterior sockets are finely transversely grooved. The most striking feature of this assemblage is the presence of a relatively strong, elongate and moderately high tubercle on the posterior half of **AI**. The tubercle, which represents **1** in the Bernard system of numbering, is here clearly lateral in position, being located parallel with the ventral margin of the hinge-plate, and having its posterior end distinctly in front of and slightly ventrad of the anterior end of **3a**.

The socket between **3a** and **3b** is an elongate triangle, whose apex lies approximately at the posterior two-thirds of its total length. Tooth **3a** margins the anterodorsal side of this socket, but its anterior termination is furnished by the posterior end of the tubercle **1** on **AI**.

A comparison of this hinge (Fig. 1) with the adult hinge (Fig. 4) reveals that the principle modifications have occurred in the anterior part of the structure, particularly in the shape and position of teeth **3a** and **1**, and in the total reduction of the remaining part of the anterior lateral lamina **AI**. On a purely mechanical interpretation, the changes might be ascribed to the posterior migration of the tubercle **1**, from its anterior lateral position to one that is almost wholly subumbonal. This migration has brought it into approximate contact with **3a** and has forced that tooth to change its shape from a narrow lamina to that of an inverted triangle that has its apex on the ventrad side where it is in juxtaposition with **1**. Coincidental with this change in shape there is a sharp change in the orientation of the tooth. Initially it is subparallel with the anterodorsal margin so that its long axis virtually intersects the anterior extremity of the valve (Fig. 1); in its maximum distortion, in what must on other characters, be considered gerontic individuals, the axis of the tooth has been shifted to a position where, if projected, it would intersect the posteroventral margin of the valve (Fig. 4).

The change in shape and the migration of the axis of **3a** markedly alters the shape and proportions of the socket separating that tooth from **3b**. Initially the socket is elongately triangular with its anterior termination well in advance of the umbo; in the gerontic individuals, it has become narrow, with subparallel sides, and has its long axis trending posteroventrally.

The migration of **1**, and its conflict with **3a** changes the shape and position of the former, from its initial structure as an elongate tubercle parallel with the ventral margin of the hinge plate, to a heavy, triangular structure, whose apex is directed dorsally toward the anterior end of the base of the inverted triangle that is **3a**. In the gerontic stage of development, **3a** and **1** come to represent what is essentially a unit transverse to the hinge plate that is formed of two triangles in juxtaposition, the posterodorsal side of **1** being parallel to and separated only by a very narrow but deep groove from the anteroventral side of **3a**.

It is to be emphasized, as shown in Fig. 12, that the change in shape and migration of teeth **1** and **3a** is a dynamic process that does not appear to have become stabilized at any time during the development of the individual.

DEVELOPMENT OF THE HINGE OF THE LEFT VALVE

The changes in the hinge of the left valve are, as would be expected, essentially similar to those that mark the right. The smallest complete specimen of this valve available for study has a length of 10.5 mm and a height of 10.2 mm. There are, however, smaller though incomplete individuals that probably did not exceed 6 mm in length, in which the hinge is adequately pre-

served for the purposes of this study. The largest specimens in the collection have lengths of 60.7 and 61.8 mm, and heights of 58.0 and 52.0 mm, respectively.

The immature hinge of the left valve (Fig. 5) consists of a long, thin anterior lamella that is parallel to the ventral margin of the hinge plate. This lamella bears two elevations on its outer face that are separated by a somewhat lower area which is, however, distinctly raised above the general level of the hinge plate itself. The anterior of these elevations clearly represents **AII**; the posterior, which is somewhat swollen toward its obliquely terminated posterior end, represents **2**, but there is no feature visible that would distinguish it as either **2a** or **2b**, or as a union of both.

In addition to these elements there is a thin, obliquely transverse **4b**, and an elongate, strong, **PII** that is markedly transversely striated. In the smallest specimens available, the **AII** is smooth, but it too, soon becomes transversely striate, the striae being well developed on a specimen 10.5 mm. in length.

The subsequent modification of this hinge is, like that of the right, mechanically a factor of the migration and enlargement of **1**. In the earliest stages there is a slight flattening of a portion of the ventral side of **AII** (Fig. 6) marking the position of tubercle **1**, which is still located on the lamella **AI**. This becomes enlarged, particularly in the low area between **AII** and **2**, until the lamella of which these two are a part is disrupted with the posterior end of **AII** being deflected dorsally. At this stage (Fig. 7), tooth **2** is elongately triangular and relatively quite heavy. The apex of the triangle so formed lies immediately below the umbo, the posterior dorsal slope is short, almost vertical, while the anterior dorsal slope is at least two and a half times as long as the posterior and trends obliquely forward.

As the progressive posterior movement of **1** continues and involves the **3a**, these two teeth encroach into the space between **AII** and **2**, completely separating them and resulting in a progressive modification of their shape. Cardinal **2** becomes more and more equilaterally trigonal, and tends to develop a broad "V" shaped groove on its ventral side; **AII** tends to maintain the position of its anterior part at the ventral margin of the hinge-plate, while its posterior part is more and more deflected dorsally, with the result that the anterior part becomes elongately trigonal in shape, with a relatively tenuous "tail" projecting posteriorly from the apex of the triangle formed of the posterior part of the original lamella[1] (Fig. 8). A continuation of this "tail" across the interspace between **AII** and the anteroventral edge of **2** forms the low, acute ridge that separates the interspace into sockets for the reception of **1** and **3a** of the right valve. This stage of development of the left hinge might be termed an adolescent one and is the stage that was figured by Stephenson (1923, pl. 66, fig. 4).

Continued modification eventually results (Fig. 9) in a **2** that is broadly heavy, rather than trigonal in shape, and which trends obliquely posteriorly, so that a line drawn through the axis of the tooth and prolonged to the shell margin would approximately cut the middle of the posterior end of the valve. At the same time **AII** loses its "tail" and becomes more and more strongly triangular in shape eventually forming a strong, almost equilaterally triangular tooth. It is probably significant, however, that the ridge crossing the "interspace" between **AII** and **2** separating it into sockets for the reception of **1** and **3a** continues to connect the posterior side of the apex of **AII** with the anteroventral edge of **2**.

ON THE DENOMINATION OF TOOTH 2

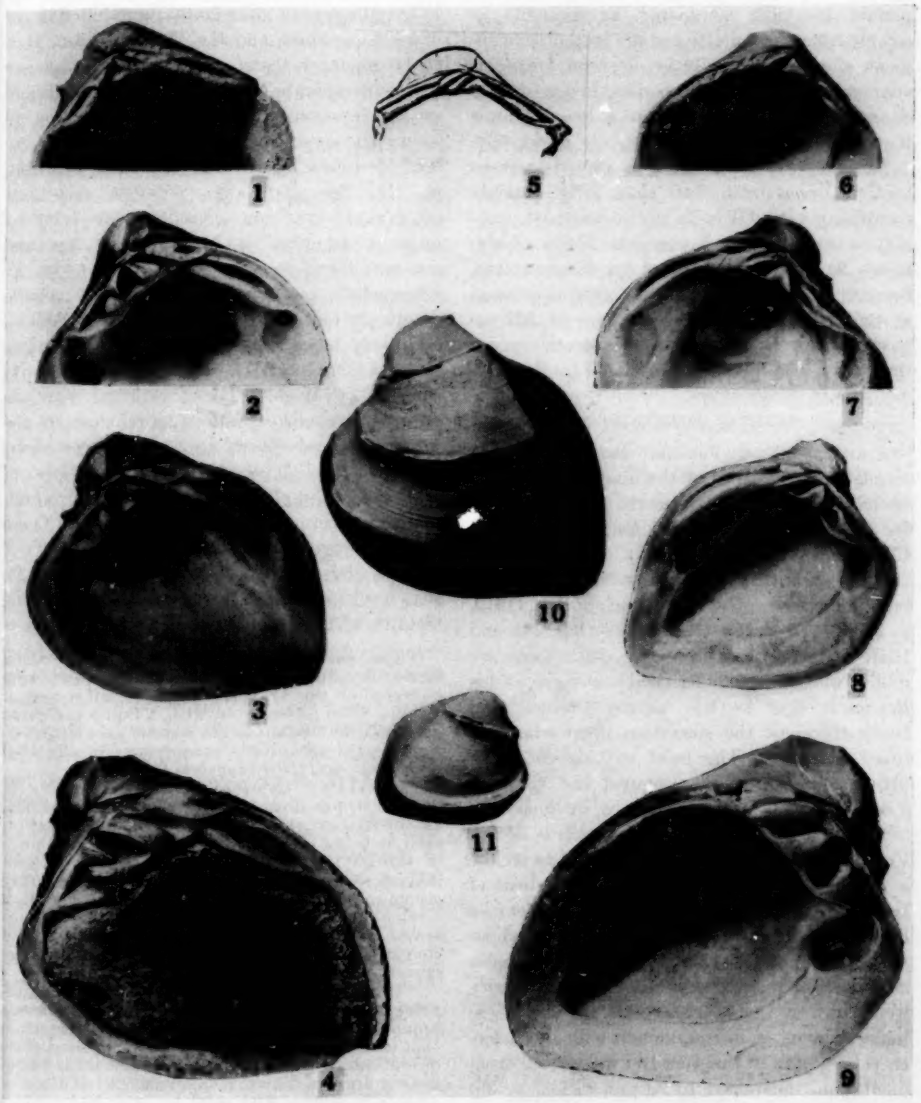
Douvillé (1913, 1921) has shown that in the development of the arcticid (cyprinid) hinge the left anterior lateral **AII** becomes extended to the center of the hinge where it abuts against **3b**, and is bent down at its posterior end to form a chevron with its apex just beneath the umbo. This downbent portion develops as **2b**. He then considered that the umbonal end of the remaining portion of **AII** later differentiated to form **2a**, leaving **AII** of the later forms as only the anterior end of the original lamellar tooth.

Casey (1952, pp. 123–5, text fig. 1) postulates a lucinoid ancestor for the cyprinoid group. In a series of drawings he shows the lucinoid ancestor as having a bifid **2** and a distinct **AII**. In the next stage, which he labels the "cyprinoid" stage, the two limbs of the bifid lucinoid "**2**" are designated as $\mathbf{2b}_1$ and $\mathbf{2b}_2$, and a distinct **2a** is forming on the anterior end of **AII**. In his "advanced cyprinoid" and "early cyrenoid" stages

[1] Since this is clearly part of the original lamella it cannot be called a *vinculum* (Casey, 1952, p. 124), since that term by definition is applied to secondary shelly matter only.

2a becomes strengthened and begins to separate from the posterior end of **AII** as it migrates posteriorly, displacing the anterior prong **2b**$_1$ of the lucinoid tooth. In the final stage, "cyrenoid" stage **2a** has become completely separate from **AII** and assumed a position identical with that originally held by prong **2a**$_1$.

Since there is never more than one element of the tooth **2** complex visible in the Veniellid hinges available for study it is not clear just



FIGS. 1–11.—*Veniella conradi* (Morton): 1–4, Development of the hinge of the right valve: (1)× 5; (2) × 2; (3, 4) × 1. 5–9, Development of the hinge of the left valve, (5) × 6, (6) × 5; (7) × 2; (8, 9) × 1. 10–11, Exterior of left and right valves: (10), same specimen as Fig. 8, × 1.3; (11) same specimen as Fig. 1, × 3. Figs. 2, 7, specimens from Ripley formation, Owl Creek, Miss.; others from Coon Creek tongue, Ripley formation, Coon Creek, Tenn.

which part is represented. In the earliest stages (fig. 5) there is a suggestion of a down-bending of the posterior end of the **AII-2** lamella that is very similar to the figures given by Douvillé (1921, p. 118, fig. 6) for the hinge of *Eotrapezium germari* (Dunker), the types species of *Eotrapezium* Douvillé, considered by Douvillé as representing the primitive stage in the development of the cyprinid hinge. It soon loses this characteristic, however, becoming first a broadly triangular structure and later a heavy simple tooth that comes to trend obliquely posteriorly.

It seems best, therefore, to designate it as tooth **2**, recognizing that, since it is certainly continuous with **AII** in its earlier stages, it probably was formed as a complete fusion of elements **2a** and **2b**. It cannot be demonstrated, however, whether or not the **2b** element arose as a result of the downward bending of **AII**, as postulated by Douvillé, or as a separate element that was joined by **2a**, as postulated by Casey.

GENERAL OBSERVATIONS

Relationships of Veniella *and* Roudairia.—Available illustrations of the hinge of *Roudairia undata* (Conrad), the presently accepted name for the genotype species of *Roudairia* Munier-Chalmas 1881 are not wholly satisfactory for comparison with those of *Veniella*. Perhaps the best are those given by Pervinquière (1912, p. 230, pl. 15, figs. 9–13, especially figs. 11b and 12a). By a particularly good fortune these are re-illustrations of Munier-Chalmas' types of his *Roudairia drui* [=*Opis undata* Conrad] and hence represent the specimens upon which he based his genus. The most striking difference between the hinges there figured and those of *Veniella conradi* is the persistence, in *Roudairia*, of the right anterior lateral **AI**, which is lost in *Veniella*, and in the effect this tooth has on the left anterior lateral **AII**. This tooth instead of being broadly triangular and heavy, as in *Veniella* is split into an inverted "V"-shaped unit whose two narrow prongs margin **AI** anterodorsally and posteriorly. This condition is particularly well-shown by Quaas (1902, pl 24, fig. 22). These hinge differences, in conjunction with the differences in weight of the shell and in external ornamentation, mentioned by Olsson (1934, p. 39) justify the retention of *Roudairia* as a separate genus, rather than relegating it to the synonymy of *Veniella*, as has been done by Newton (1909, p. 69), Wade (1926, p. 77), Rennie (1929, pp. 26–8; 1930, p. 191), Cox (1952, pp. 18, 19), and others.

Roudairia and *Veniella* were, so far as can be determined from published records, contemporaneous genera. Both ranged from the Turonian[2] through the Maestrichtian, and both seem to have been most abundantly represented in the upper Campanian and the Maestrichtian.[3] It is to be assumed therefore that the two genera represent separate essentially parallel evolutionary developments within the very plastic arcticid stock. The specimens from Pondoland and Zululand identified by Rennie (1930, pp. 192, 244, pl. 29, figs. 1–5) as "*Veniella forbesiana* (Stoliczka)" are now considered as being of upper Campanian or Maestrichtian age and can not, therefore, be considered as having an intermediate position between the two genera, despite the fact that they show a greatly reduced, essentially tubercle-like, **AI** with a corresponding strengthening of **AII**, called the left anterior cardinal by Rennie. These, together with the strong transverse striations developed on the posterior laterals closely approach the conditions observed in *V. conradi*. The illustrations of Stoliczka (1870, pl. 9, figs. 2–8) are too diagrammatic to permit certain comparisons. There seems, however, to be differences in the posterior laterals and possibly also in the shape of **3a**, that would justify at least a question as to the identity of Rennie's species. The Albian species

[2] The specimens of *Veniella mortoni* Meek figured by Stanton (1893, pl. 23, figs. 6–9) were collected on the Arkansas River, 18 miles west of Pueblo, Colo., associated with a fauna including such characteristic Carlile species as *Collignoniceras hyatti* (Stanton), *Inoceramus fragilis* Hall and Meek, and *Ostrea lugubris* Conrad.

Stoliczka's "*Cyprina*" *forbesiana* (1870, p. 192, pl. 9, figs. 2–8) was described from the Trichinopoly Group of India, now generally considered as being of Turonian age. The figured hinge of the left valve shows the characteristic split **AII** of *Roudairia*, while that of the right valve seems to lack an anterior lateral, thus suggesting *Veniella*. Since, however, the species clearly possesses the strong carinate post-umbonal ridge of *Roudairia*, its reference to that genus seems more correct.

[3] It is recognized that the application of European stage names to the geologic range of *Veniella* applies a precision of intercontinental correlation that is not wholly in accord with the present state of our knowledge. Nevertheless, since these correlations are based mainly upon the distribution of ammonite genera who seem to have had a more rapid rate of migration than the heavy-shelled pelecypods, it is believed that the correlations implied above are sufficiently close to have real significance when applied to the genera under consideration.

"Veniella" etheridgei Newton, as figured by Rennie (1931, p. 242, pl. 31, figs. 1–3) differs entirely in the nature of the posterior lateral and in the bifid condition of tooth **2** of the left valve. The drawing of the hinge is such as to make it uncertain just what condition exists with respect to **AII**; it might be that the tubercle-like structure shown at the posterior end of the structure represents **2a**, in which case the bifid tooth would be **2b** and the species would be entirely separate from the *Veniella-Roudairia* complex. In general, the hinge suggests a closer relationship to *Venilicardia* than to *Veniella*.

Relationship of Cicatrea *Stoliczka*.—Stoliczka (1870, p. 191) described the subgenus *Cicatrea* with *Cyprina* (*Cicatrea*) *cordialis* Stoliczka (1870, p. 199, pl. 10, figs. 1, a, b, c, 2) as the type species. Among the important generic characters mentioned were: (1) "a rather short but deeply bifurcate groove in which the ligament is lodged." (2) "The posterior cardinal teeth are rather narrow in both valves . . . the two anterior cardinals in the left valve are very large, the same superimposed teeth in the right valve, however, very small." (3) "The anterior muscular impression is anteriorly margined by a sharp ridge."

Douville (1904, p. 216), on the basis of a specimen from Madagascar, which he unfortunately did not figure, concluded that *Cicatrea cordialis* was actually a *Roudairia* and that *Cicatrea* Stoliczka was therefore a prior name for Munier-Chalmas's genus. He refused, however, to adopt the Stoliczka name on the grounds that it had not been accurately defined. Rennie (1929, p. 27) discusses the matter at some length and points out that the difference between the nymph structure described by Stoliczka and that observed in *Roudairia* is probably due to imperfect preparation of the Indian specimens. It should be pointed out, however, that the heavy, triangular "left anterior cardinal" described and figured by Stoliczka (pl. 10, fig. 2) is totally unlike that to be seen in illustrations of *Roudairia undata*, but is entirely like the condition found in adult specimens of *Veniella conradi*. In neither genus, however, is there any suggestion of the "sharp ridge" in front of the anterior muscle scar, described by Stoliczka, and no structure has been observed that corresponds to the peculiar feature shown in this area in his illustration. If it is not actually present in the species and represents extraneous material impressed into the shell, then it seems more likely that *Cicatrea* may be regarded as a synonym of *Veniella* rather than *Roudairia*. Since *Veniella* Stoliczka is a new name proposed as a substitute name for *Venilia* Morton, 1834, and also has page priority in Stoliczka's work, *Cicatrea* could safely be discarded, without endangering *Roudairia*.

Petalocardia *Vincent*.—In 1924 E. Vincent (1924, pp. 59–62, text figs. 1, 2) proposed *Petalocardia* as a subgenus of *Veniella*, with *"Venus ?" pectinifera* Sowerby, from the Upper Eocene, Bartonian, of England, Belgium and France as the type species. This is a small form that has in common with *Veniella* external lamellar flanges and a moderately sharp posterior umbonal ridge. In the right valve **3a** trends diagonally forward across the hinge-plate coming into apposition with the upturned posterior end of **AI**, which, in Vincent's figure seems to possess a small tubercle possibly representing an incipient cardinal **1**; **3b** is strong and broadly grooved, while **PI** (labelled **LP2**, by Vincent) is strong and smooth, with a broad, deep socket above it for the reception of **PII**. In addition, however, there is a well-developed **AIII**. The left hinge has a triangular **2** (labelled **2a** by Vincent), and a lamellar **4b**, both of which are similar to those in immature

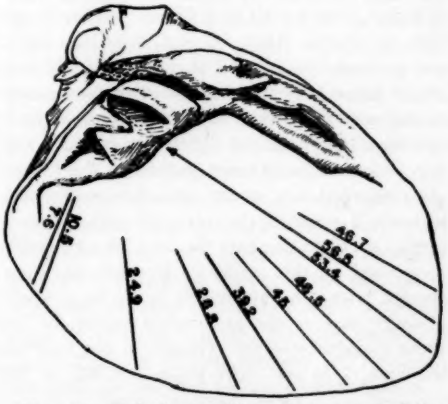


FIG. 12.—Relative position of the trend of the ventral, later posterior, margin of **3a** during the development of the individual. The lines indicate the relative trend of the margin with respect to the outline of the valve in specimens whose length is indicated, in millimeters, adjacent to the trend line. The specimen of 46.7 mm length represents an unusually obese gerontic individual from Brightseat, Maryland. Specimens of 24.9 and 28.8 mm length are from the Ripley formation at Owl Creek, Miss. All others from the Coon Creek tongue of the Ripley formation, Coon Creek, Tenn.

specimens of *Veniella conradi* (see fig. 7); **AII** is transversely elongate and shows no evidence of former connection with **2**, while **PII** (called **LP1**, by Vincent) is short, with a peculiar ventral projection from the hinge plate to accommodate the socket for **PI**. The inner margin of both valves is strongly crenulate. Externally, as figured by Glibert (1933, p. 156, pl. 9, fig. 9) and Cossmann (1883, p. 169, pl. 6, fig. 7, 7a), surface of the valves between the flanges shows a well-developed radial ornamentation.

The external radial ornamentation, denticulate inner margins, and, in the right valve, the presence of **AIII** and the smooth **PII**, together with, in the left valve, the distinct separation of **AII** from **2**, and the short discreet **PII** with its unusual ventral socket arrangement, all serve to distinguish *Petalocardia* from *Veniella*. These factors, together with the long time interval between the last known representatives of *Veniella* and the appearance of *Petalocardia*, justify the divorcement of the latter from *Veniella*, and its recognition as a distinct genus.

Comparison with Arctica *Schumacher s.s.*—A comparison of the figure of a specimen of *"Cyprina" islandica* (Linné) with a length of but 6 mm, given by Bernard (1895, p. 129, text fig. 14) with specimens and figures, such as those given by Nicol (1951, p. 103, text fig. 103) or Theile (1934, p. 856, text fig. 819), seems clearly to indicate that the development of the hinge here described for *Veniella conradi* is also essentially that which occurs in *Arctica*[4] *islandica*. The principal differences between the two so far as the anterior portion of the hinges are concerned are: in the immature specimens, in tooth **2** which is distinctly divided into two limbs, so that elements **2a** and **2b** are easily recognized at this stage of development, even though later they apparently unite to a single element; and, in the more adult valves, in the great variability of the strength of the anterior elements, **1** in the right valve and **AII** in the left. In many specimens of *Arctica* these are reduced to deeply corrugated remnants, or, as in the diagrammatic drawings given by Cox (1947, p. 144, text fig. 8a, b) to minute tubercles. In other specimens, however, notably in that figured by Nicol, both of these teeth are strongly and heavily developed, being very similar, in this respect to the condition that is maintained in *Veniella conradi*.

Developmental stages in the growth of the Veniella *hinge.*—It has already been pointed out that Douvillé considered the earliest stage in the evolution of the arcticid hinge to be that in which **AII** becomes extended to the center of the hinge line and is bent down at its posterior end to form a chevron with its apex just below the umbo. This he designated the *"Eotrapezium* stage." The smallest left valves present in our collection show this condition. No equally minute right valves are available for study. However, there is a suggestion of a small socket dorsal to the **AII-2** combination in the lefts that suggests the presence in the right valves of a small **3a**; if present it would indicate that even at this small size, the species had passed beyond the *Eotrapezium* stage, since a **3a** is not present in that genus.[5]

Cox (1947, p. 142) in a review of the British Jurassic species, recognizes three groups of species within the family, stating: "In the right valve, at a slightly more advanced stage than that of *Eotrapezium*, a small excrescence appears at the posterior end of **AI** and is the origin of tooth **1**. In one group of forms, which includes the Recent *Cyprina*, this remains merely a tubercle, and an anterior cardinal **3a** develops close to the lunular margin with its apex touching that of **3b** below the umbo. In other forms, such as *Pronoella* and *Eocallista* of the Jurassic and *Pygocardia* of the Miocene, **1** develops into a strong triangular tooth with its apex close to the umbo; it thus becomes a median cardinal tooth inserted between **3b** and **3a**, although when it is very prominent the development of **3a** may be impeded. . . . In the posteriorly carinate *Pseudotrapezium* and the globose *Rollierella* **1** is halfway between a tubercle and a triangular tooth and **3a** is quite well developed."

[4] The name *Arctica* Moehring 1752, as republished in the 1758 translation by Nozeman and Vosmaer under the title of *Geslachten der Vogel*, was clearly not validated by that translation, being analogous with the names *Grus* and *Coturnix*, also used in that translation, that were discussed by Hemming in the re-issue of Opinion 5 of the International Commission on Zoological Nomenclature. (see "Opinions and Declarations . . . etc., vol. 1, pt. 14, esp. pp. 120–122, 1944). *Arctica* Moehring, therefore, does not invalidate *Arctica* Schumacher, 1817, and the latter is the valid name for the present genus (see also Nicol, 1951, p. 102).

[5] Casey (1952, pp. 134, 136) who provisionally accepts the genus *Eotrapezium* on other grounds, considers that the development of **3a** is so variable in the arcticids as to have no taxonomic significance. Chavan (1952, p. 83, fft. 1) does not agree with this conclusion.

It seems to the writer that the most important factor in this grouping is the relative position of teeth **3a** and **1** at the time of their early development. If **1** first appears ventral, or posteroventral, to the anterior end of **3a** then it may migrate posteriorly and assume a median position without coming into conflict with the developing **3a**; if it first appears anterior to the anterior end of **3a** its posterior migration seems to be impeded by the development of **3a**, unless the latter tooth remains as a thin lamella adjacent to the dorsal margin of the valve.

An examination of the many illustrations, often unfortunately diagrammatic, available in the literature for the old world Jurassic and Cretaceous arcticidae, especially the excellent figures of Cox (1947) and Casey (1952), suggests that the immediate post-*Eotrapezium* stage in the development of the hinge of *Veniella* would resemble the hinge of the Middle Jurassic, Great Oolite species, *Anisocardia* (*Antiquicyprina*) *loweana* (Morris and Lycett) (see Cox, 1947, pl. 9, figs. 75, 76; Casey, 1952, text figs. 49a, b, 50) the type species of the subgenus *Antiquicyprina* Casey (1952, p. 153). This hinge is almost identical with that observed in the smallest right valve of *Veniella* in our collection, except that **1** is somewhat stouter in the Cretaceous specimen.

The available figures of the Upper Jurassic, Kimmeridgian species *Anisocardia* (*Anisocardia*) *elegans* Munier-Chalmas are too diagrammatic to be of certain help here (see Douvillé, 1921, text fig. 6; Cox 1947, text fig. 5). They do, however, suggest that it is within this group of species that the continuation of the development of the Veniellid type of hinge is to be found. On the other hand, the figures of the Middle Jurassic *Anisocardia* (*Anisocardia*) *truncata* (Morris) given by Casey (1952, text fig. 48a, b) and said to agree "in all features," in the right valve at least, with that of *A. elegans* is clearly not in an ancestral position. Tooth **1** is very large and heavy, completely anterior to **3a** which has assumed a position where it crosses the entire hinge plate in an anteriorly oblique position, and seems to be displacing **2a** of the left valve in such a way that the latter could not unite with **2b**, as it clearly has at this stage in *Veniella*. In the latter genus, **1** impinges against, deflects, and later almost completely obliterates the anterior end of **AII**, not **2a**.

Certain species of the genus *Venilicardia* represent well the expectable Lower Cretaceous stage in the development of the *Roudaria* and *Veniella*-type of hinge. The figures of the Upper Greensand species *Venilicardia lineolata* (Sowerby) given by Woods (1907, pl. 22, figs. 5a, b, 6a, b, 7, 8) depict a form that in all characteristics save the nature of the left posterior lateral, **PII**, agrees with the condition found in "adolescent" specimens of *Veniella conradi* similar to those figured by Stephenson (1923, pl. 66, figs. 4, 5).

If, therefore, we may accept Douvillé's postulation of an *Eotrapezium* stage in the ancestry of the later Arcticidae, we would have such a stage represented in the, at present little known, representatives of *Veniella* that were less than 6 mm. in length. At approximately that length the hinge shows an *Antiquicyprina*-like arrangement, that seems to pass through a modified *Anisocardia*-like type to enter a *Venilicardia*-form arrangement at lengths of 30 to 40 mm. The fully developed, characteristic *Veniella* hinge does not appear until late in the life of the individual specimen.

It is to be emphasized that this is a series of stages in the ontogeny of the individual hinge and that no suggestion of actual evolutionary ancestry for *Veniella* is implied or is to be read into the generic hinge types with which the growth stages of the Veniellid hinge are here compared. The genus *Veniella* is a North American Cretaceous group so far as our present knowledge of its distribution is concerned,[6] and it is quite probable that the ancestral types were North American in their distribution also. Our present knowledge of the Jurassic and Lower Cretaceous pelecypod faunas of this continent is so very inadequate that it is not possible at this time to even consider possible ancestral types for *Veniella*. Whether the types mentioned were significant in the ancestry of *Roudairia* can only be decided by an examination of a series of immature specimens of species referable to that genus.

[6] The specimens from the Cameroon discussed and figured by Riedel (1932, p. 54, pl. 1, 1a, 2, 2a, 2b) as *Veniella mortoni* Meek do not represent that species, the left hinge of which has been figured by Stanton (1893, pl. 23, fig. 9), nor do they seem to be correctly identified generically. Two genera may be represented, Riedel's fig. 1a showing a bifid cardinal **2**, while fig. 2b has an entire **2**.

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MYCOLOGY.—*Some Discomycetes new to Alaska.* EDITH K. CASH, U. S. Bureau of Plant Industry, Soils, and Agricultural Engineering.

The extensive collections of fungi made in Alaska by Dr. Roderick Sprague during the summer of 1952 included a large number of Discomycetes which were referred to the writer for examination. Four collections were made of an apparently undescribed *Peziza*, which is therefore named here as new. Several species hitherto unreported from Alaska are proposed as new combinations, and twenty additional species of Discomycetes are also briefly listed for which Dr. Sprague's collections constitute the first reports from Alaska.

1. **Peziza alaskana,** n. sp.

Apothecia dispersa, carnea, cupulata, margine leniter undulato, ex parte in terram arenosam sepulta, extus fusco-nigra, furfuracea, hymenio

glabro, purpureo-atro vel atro, 5–12 mm in diam., 3–8 mm alta; asci teretes, apice obtusi et leniter iodi ope azurescentes, gradatim basim versus attenuati, 275–300 × 15–18 μ; ascosporae oblique uniseriatae, hyalinae, ellipsoideae, utrinque angustatae, subtiliter echinulatae, hyalinae vel pallide brunneolae; paraphyses numerosi, apicibus brunneis et usque 6–8 μ inflatis, in mazaedium brunneum agglutinati; textura excipularis hyphis pallide brunneis, laxe intertextis extus obscurioribus et furfuraceis composita.

Hab. ad terram arenosam, Alaska.

Apothecia scattered, fleshy, partially buried in sand, deep cup-shaped, margin slightly undulate, exterior fuscous-black,[1] furfuraceous, hymenium smooth, dull purplish black, 5–12 mm in diameter, 3–8 mm deep; asci terete, obtuse at the apex, faintly blue with iodine, gradually attenuated toward the base, 275–300 x 15–18 μ; ascospores obliquely uniseriate, hyaline, ellipsoid, narrowed at the ends, minutely echinulate, hyaline to pale brownish, 22–24 x 9–10 μ; paraphyses numerous, brown and swollen to 6–8 μ at the tips, becoming agglutinated into a dark brown mazaedium; exciple of pale brown, loosely interwoven, rather thin-walled hyphae, the outer layer darker and roughened by loose ends or clumps of hyphae.

ALASKA: Mendenhall area, July 9, 1952, R. Sprague *3*[2]; Crocker Station no. 1, Mendenhall Glacier area, July 11, 1952, *20*, *type*; Herbert Glacier area, July 19, 1952, *100*; base of Red Mountain, Glacier Bay National Monument, August 12, 1952, *259*, and Bear Track Cove, Glacier Bay National Monument, August 23, 1952, *469*.

This small black *Peziza* resembles *Peziza brunneo-atra* Desm. in some respects, but the spores are narrower and more pointed and finely echinulate rather than verrucose. The apothecia in *P. alaskana* also remain deep cup-shaped, never becoming applanate as in *P. brunneo-atra*, and the hymenium is purplish-black, not tinged with green. The pale brown spores suggest *Aleurina* but they are evenly and finely echinulate, not reticulate.

[1] Color readings are from RIDGWAY, R., *Color standards and color nomenclature*. Washington, 1912.

[2] Collection numbers throughout are those of Roderick Sprague.

2. **Paxina arctica** (Nannf.), n. comb.

Helvella arctica Nannf. Svensk Bot. Tidskr. **31**: 60, illus. 1937.

ALASKA: Glacier Bay National Monument: Anchorage Cove area, August 9, 1952, *232*, and Forest Creek area, August 15, 1952, *276* and *282*.

Helvella arctica was reported from arctic and subarctic regions of Sweden and Spitzbergen by Nannfeldt. The Alaskan collections agree with the original description and illustrations, and with type material issued in Lundell & Nannf. F. Exsicc. Suec. *369*. The species may be readily recognized by the furfuraceous white margin surrounding the black hymenium. If *Paxina* is recognized as distinct from *Helvella*, the species would belong to the former genus.

3. **Helotium stipae** (Fckl.), n. comb.

Trichopeziza stipae Fckl. Symb. Myc. p. 297. 1869.
Helotium stigmaion Rehm Hedw. **21**: 99. 1882.
Helotium stigmaion Rehm var. *minusculum* Rehm Ascom. no. 767. 1883; Hedw. **24**: 13. 1885.
Phialea stipae (Fckl.) Rehm Kryptogamenfl. Bd. 1, Abt. 3, p. 734. 1893.

ALASKA: on *Phleum alpinum*, base of Red Mountain, Glacier Bay National Monument, August 12, 1952, *613*; *Poa alpina*, lake shore, Mendenhall Glacier area, July 9, 1953, *52*; *Poa arctica*, Mount Gastineau, July 18, 1952, *264*; *Poa compressa*, Glacier Bay National Monument, August 18, 1952, *743*; *Poa trivialis*, Mendenhall Glacier area, July 10, 1952, *62*.

This inconspicuous species, apparently confined to grasses, is reported by Rehm on *Stipa* and *Phleum*. The Alaskan specimens agree with Thuemen Mycotheca univ. no. *2020* on *Phleum pratense* and Krieger F. Saxon. *1835* on an undetermined grass. No record has been found of its occurrence in North America.

4. **Dasyscypha aspidii** (Lib.), n. comb.

Peziza aspidii Lib. Pl. Crypt. Ard. no. *226*. 1832.
Trichopeziza aspidii (Lib.) Fckl. Symb. Myc. p. 297. 1869.
Lachnum aspidii (Lib.) Karst. Meddel. Soc. Faun. Fl. Fenn. **16**: 27. 1888.

ALASKA: On *Dryopteris* sp., Sebree Island, Glacier Bay National Monument, August 19, 1952, *369*.

As pointed out by Dennis, the use of the generic name *Lachnum* sensu Rehm for species of *Dasyscypha* with lanceolate paraphyses has no justification; the species is therefore referred to *Dasyscypha*.

In addition to the fungi listed above, Dr. Sprague's 1952 collections include the following Discomycetes not previously reported from Alaska: *Ascobolus glaber* Pers. ex Fr. on grizzly-bear dung, *Belonioscypha campanula* (Fr.) Rehm on *Hordeum*, *Dasyscypha calyculiformis* (Schum. ex Fr.) Sacc. on *Salix*, *D. leucophaea* (Pers. ex Weinm.) Mass. on *Lupinus nootkatensis*, *D. virginea* (Batsch ex Fr.) Fckl. on *Populus trichocarpa* and *Salix alaxensis*, *Helotium caudatum* (Karst.) Vel. on *Alnus*, *H. cyathoideum* (Bull. ex Fr.) Karst. on *Equisetum virgatum*, *Epilobium latifolium*, and *Bosnickia*, *H. leucellum* Karst. on *Alnus*, *H. scutula* (Pers. ex Fr.) Karst. on *Dryas drummondii* and *Epilobium*, *H. virgultorum* (Vahl ex Fr.) Fr. on *Alnus* and *Sambucus*, *Humaria hemisphaerica* (Wigg. ex Fr.) Fckl., *H. umbrorum* (Fr.) Fckl., *Lamprospora amethystina* (Quél.) Seaver, *L. constellatio* (Berk. & Br.) Seaver, and *Mollisia uda* (Pers. ex Fr.) Gill. on *Alnus*, *Otidea auricula* (Cke.) Rehm, *Pyrenopeziza karstenii* Sacc. on *Agropyron trachycaulum* and *Poa*, *Rutstroemia nervisequia* (Schroet.) W. L. White on *Alnus*, *Stamnaria persoonii* (Moug. ap. Pers. ex Fr.) Fckl. on *Equisetum*, and *Tapesia fusca* (Pers. ex Fr.) Fckl. on *Alnus*, *Salix*, and *Shepherdia*.

ZOOLOGY.—*Description of* Eocyzicus concavus (*Mackin*) *with a review of other North American species of the genus* (*Crustacea: Conchostraca*). N. T. MATTOX, University of Southern California.[1] (Communicated by F. A. Chace, Jr.)

In a key to the phyllopods of Oklahoma and neighboring states, Mackin (1939) listed a previously undescribed species under the name *Estheria concava*. As a result of personal communications Dr. Mackin informed me that the original four specimens, on which the key characters were based, had been lost. However, another collection from the same locality contained eight specimens which Dr. Mackin kindly presented to me for study. Careful examination of these specimens resulted in the unquestionable decision that the species should be assigned to the genus *Eocyzicus* Daday, 1915. I was then asked by Dr. Mackin to make a complete description of this unusual and interesting conchostracan.

Meanwhile there appeared in the key to the North American phyllopods by Pennak (1953) a listing of a species, presumably the species here under consideration, indicated as *Eocyzicus concava* Mattox. The original designation by Mackin must be recognized even though it was based on the following incomplete diagnosis: "Rostrum shaped like a hatchet blade; with a row of large smooth spines along the mid-dorsal line, one spine for each trunk segment; hand of the male deeply incised at the base of the thumb; shell sway-backed." The diagnosis given by Pennak was: "Rostrum like hatchet blade; with large, smooth spine on the middorsal line of most trunk segments; rare, poorly known; Okla." The specific name must be that of Mackin even though the generic designation is invalid. *Estheria* Ruppell 1837 as used for the Conchostraca is a homonym, as the name *Estheria* was first used for a genus of Diptera by Robineau-Desvoidy in 1830. The name *Estheria*, for conchostracans, is replaced by *Cyzicus* Audouin, *Eocyzicus* Daday, *Caenestheria* Daday, *Caenestheriella* Daday, *Leptestheria* Sars, *Eoleptestheria* Daday, *Leptestheriella* Daday and *Cyclestheria* Sars. The original trivial name of the species under consideration, must be changed to agree with that of the genus, hence the name *Eocyzicus concavus* (Mackin, 1939) is here given. Since the species has not previously been completely described a description is here presented and a neotype is designated. These animals were collected on August 12, 1928, in a temporary pool near Summerfield, Tex.

Eocyzicus concavus (Mackin)

Description.—Male: The shell is elliptical with a straight dorsal hinge line extending two-thirds the shell length, and with a rounded ventral margin (Fig. 1, *a*). Posterior to the hinge the dorsal edge is straight extending ventrally at approximately a 20° angle. The anterior shell margin is rounded, extending ventrally very abruptly; the posterior portion is more attenuated. The greatest height of the shell is slightly

[1] Department of Zoology, Allan Hancock Foundation. Allan Hancock Foundation Contribution no. 124.

anterior to the middle. The umbone is very conspicuous extending dorsally above the hinge line and located approximately one-fifth the shell length from the anterior edge. The anterior slope of the umbone extends abruptly ventrad, the posterior slope is more gradual. The form of the umbone gives a "sway-backed" appearance to the shell. The lines of growth on the six male shells in the collection varied in number from 18 to 22. The average shell size was 6.9 by 4.2 mm, a shell width-length ratio of 1:1.6.

The head of the male possesses the characters typical of the genus as established by Daday (1915). Those characters are the roundly ex-

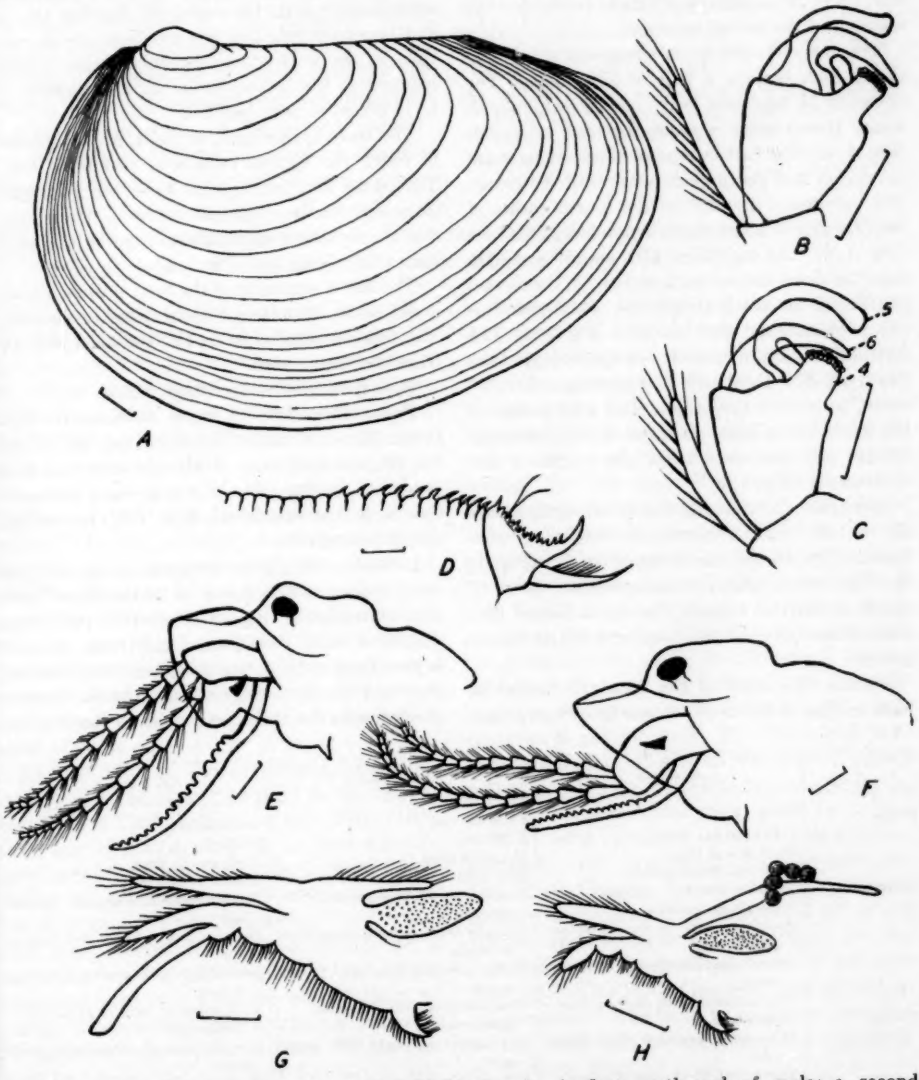

FIG. 1.—*Eocyzicus concavus* (Mackin): *a*, Shell of male; *b*, first gnathopod of male; *c*, second gnathopod of male (4, 5, 6—fourth, fifth, sixth endite); *d*, lateral view of dorsal portion of trunk and the telson; *e*, lateral view of head of male; *f*, lateral view of head of female; *g*, male third appendage; *h*, female ninth appendage with eggs attached to epipodite. Scales all equal 0.5 mm.

tended and shallowly notched occipital region, also the broadly spatulate rostrum when viewed in profile (Fig. 1, *e*). The dorsal surface of the front is slightly concave. The anterior flagellum of the second antennae is composed of 12 segments, the posterior flagellum of 14 segments. The first antennae are elongate, dorsally papillose, up to 20 papillae, and extend to the seventh segment of the second antennae.

The body, or trunk, is composed of 19 segments each bearing a pair of appendages. The posterior 11 segments bear a middorsal, smooth spine; the anterior 8 segments bear no spines (Fig. 1, *d*). The first two pairs of appendages are developed into gnathopods, typical of the group. The palpiform "thumb" of the fourth endite of the first pair of gnathopods is notched at its base (Fig. 1, *b*). The digitiform fifth endite is shorter than the sickel-shaped sixth endite. On the second gnathopod the notch at the base of the thumb is not as pronounced as in the first (Fig. 1, *c*). The fifth endite is approximately one-third longer than the sixth. The third pair of appendages is foliaceous, as are all the others. The fifth endite of the third appendages possesses a digitiform extension approximately twice the length of the sixth endite (Fig. 1, *g*).

The telson is truncate, shortened, with a pair of ventral, curved cercopods extending posteriorly beyond the dorsal telson spines (Fig. 1, *d*). The telson dorsal ridges possess 16 or 17 spines of variable length. The dorsal forked filament arises between the third and fourth telson spines.

Female: The shell of the female is similar in form to that of the male; no marked dimorphism is evident. On the two female shells in the collection each contained 22 growth lines.

The head of the female has the form characteristic of the genus. The rostrum, in profile, is accuminate; the occipital area is rounded and with a shallow notch (Fig. 1, *f*). The front is straight, not concave as in the male. The second antennae are as in the male, the flagellae are 12 and 14 segmented. The first antennae are shorter than in the male extending only to the fourth segment of the second antennae and possess 15 to 18 dorsal sensory papillae.

The body appendages, 19 pairs, are all similar in form, the typical foliaceous swimming legs. The ninth and tenth pairs have the epipodite elongated for the ovigerous function. The epipodite of pair nine is approximately one third longer than that of pair ten (Fig. 1, *h*).

The last 9 segments of the body possess a middorsal spine, the anterior 10 segments are smooth. The telson is similar to that of the male with 16 pairs of dorsal spines.

Type locality.—Summerfield, Texas.

Type.—Deposited in the U. S. National Museum. Neotype, male, U.S.N.M. no. 95731. As the original specimens of Mackin were lost it is necessary to designate the type as a neotype. One male and one female U.S.N.M. no. 95732, also deposited.

Remarks.—*Eocyzicus concavus* represents the third species of the genus to be described from this continent. *E. digueti* (Richards, 1895) was described from Purissima, Calif., and *E. vanhöffeni* Daday, 1915, was described from Mexico, the exact locality being uncertain. In the absence of specimens for direct examination the descrip-

	E. digueti	*E. vanhöffeni*	*E. concavus*
SHELL	8.5 × 3.5 mm.	8.6 × 4.8 mm.	6.9 × 4.2 mm.
	1:2.4 shell size ratio	1:1.8 ratio	1:1.6 ratio
	14–16 growth lines	26 growth lines	18–22 growth lines
	Male and female similar	Male shell more rounded dorsally	Similar in two sexes
HEAD	Female rostrum elongate and sharply accuminate	Female rostrum short, roundly accuminate	Female rostrum regularly accuminate
	Occipital notch of female deeper than in male	Occipital notch of male deeper than in female	Occipital notch of two sexes equal
	Second antennae flagella 12–13 segments	Second antennae flagella 14–16 segments	Second antennae flagella 12–14 segments
	First antennae with 13–18 papillae	First antennae with 14 papillae	First antennae with 15–20 papillae
TRUNK	16 segments	16 segments	19 segments
	14 posterior segments with dorsal spine	14 posterior segments with dorsal spine	9–11 posterior segments with dorsal spine
	Telson with 12–15 pairs of spines	15 pairs of telson spines	16–17 pairs of telson spines
APPENDAGES	Male "thumb" of gnathopod cleft deeply	Male "thumb" with deep basal cleft	Male "thumb" with shallow cleft
	Tenth epipodite of female twice length of ninth	Ninth epipodite of female twice length of tenth	Ninth epipodite of female one-third longer than tenth

tion given by Daday for *vanhöffeni* has been used as a basis of comparison. The comparison with *digueti* has been facilitated by a recent acquisition of a collection of 3 males and 1 female from near Reno, Nev. This represents a new locality record for this species as it had been previously known from only the type locality. In addition to the characters indicated in the foregoing table, *concavus* differs from *digueti* in a number of other features. The hinge line is proportionately much shorter, the umbones are less prominent in *digueti*, and it does not have the "sway-back" appearance of *concavus*. In *digueti* the first antennae of the male extend only to the fifth or sixth segment of the second antennae; the telson is more truncate, and the cercopods are proportionately shorter than in *concavus*. Also, the "thumb" of the male gnathopods of *digueti* are much more deeply cleft at the base than in *concavus*. A tabulated comparison of the three species is given on the opposite page.

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ZOOLOGY.—*Further studies on American millipeds of the family Euryuridae (Polydesmida)*. RICHARD L. HOFFMAN, Clifton Forge, Va.

My previous paper dealing with the American euryurids (1951) endeavored to provide a summary of the genera recognized by me at the time of its writing in early 1950. Since that time I have accumulated additional pertinent information and have come to realize that my reliance upon Attems's treatment of the group in *Das Tierreich* (1938) was in many instances ill-advised. In all, so many changes are necessary in the arrangement of the genera of this family that a second paper becomes advisable. While aware of the limitations imposed by the acute lack of critical study material, I am nonetheless convinced that even preliminary attempts at synthesis are badly needed at present. Half a loaf is better than none at all.

In the light of the preceding comments it may seem improper to refer to the works of the late Carl Attems in any vein other than one of utmost respect. Attems was the only recent worker with the industry and ability to produce manuals of the scope of his 3-volume "Polydesmoidea," yet while this magnificent compilation stands as a memorial to its gifted author, its minor imperfections will long be the despair of the uncritical user. Outstanding are Attems's disregard of the works of some of his colleagues (notably Cook and Silvestri), and a most remarkable indifference to the principles of type fixation. Some of these idiosyncrasies will be noted further on in the text.

Aside from information gathered from the literature, I have based this paper to a considerable extent upon Central American specimens preserved in my personal collection and that of the United States National Museum. This study material is very uneven as regards the genera represented. In the case of *Pseudamplinus*, I have adequate material to justify the preparation of a generic revision, which is now in progress. There seems to be no advantage in delaying the descriptions of the various new forms in other genera, however; these are given herewith, with at least a modicum of attention to their relationships to established species. In general the present paper is concerned with changes and additions on a generic level. It is assumed that the reader has access to the earlier paper mentioned above, which lists the species in the various genera not dealt with here.

It is with pleasure that I must again mention my increasing indebtedness to Dr. E. A. Chapin, for access to the collections of the National Museum and for much advice and information pertinent to the completion of the present study. I am also grateful to Dr. W. J. Gertsch, through whose cooperation I was able to examine material in the collection of the American Museum of Natural History.

Family EURYURIDAE Pocock

Trachelorhacidae Silvestri, Boll. Mus. Torino **13** (324): 5. 1898 (based upon *Trachelorhacis* Silvestri, a preoccupied name).

Euryurinae Pocock, Biologia Centrali-Americana, Chilopoda and Diplopoda: 113, 147. 1909.
Euryurini Brolemann, Ann. Soc. Ent. France **84**: 584. 1915.
Euryuridae Chamberlin, Bull. Mus. Comp. Zool. **62**: 249. 1918.—Hoffman, Proc. U. S. Nat. Mus. **102**: 235. 1951.

Genera.—18, of which 13 are found in the Western Hemisphere.

Range.—North Carolina, western Pennsylvania, and Minnesota south through Central America to Ecuador, northeastern Peru, and northern Brazil. Celebes, Halmaheira, Ternate, Timor, and the Solomon Islands.

Definition.—A small family of the suborder Eurydesmidea (= Leptodesmidi of Brolemann, 1915), resembling the Platyrhacidae in the presence of (1) closely-set antennae each subtended by an oval swelling, (2) small sternites with the legs basally approximate, (3) a broad distally truncate terminal segment (telson), and (4) small, rather simple gonopods in a proportionately small, somewhat diamond-shaped aperture. The gonopods are similar in lacking a definite prefemoral process. From the Platyrhacidae, the members of this family differ chiefly in that the repugnatorial pores are located in the sides of definite marginal swellings of the keels. The pores in species of the Platyrhacidae are more or less remote from the edges of the keels, and are encircled by a flat polished area; the keels themselves have no marginal ridges or thickenings. In the absence of any intermediate condition, it seems best to follow the example of my predecessors, who have found it expedient to set the euryurid genera apart in a separate family. Attems, however, lumps the two groups in his recent (1938) survey.

With the increasing significance that is being attached to the taxonomic value of the male genitalia, it appears possible to further divide the euryurids into several groups of genera, each rather discrete and readily defined. Since the recognition of such ensembles is a substantial aid to an understanding of the affinities of the genera, I think it advisable to designate them by the use of subfamily names, proposed towards the conclusion of the discussion.

A comment on the use of the family name may be of interest. In 1938 Attems proposed the name *Eutheatus* as a substitute for *Euryurus* of Koch, 1847, as the latter name had already been published in 1815 by C. S. Rafinesque for a group of polychaete annelids. I have examined a copy of the Rafinesque paper, the *Analyse de la nature ou Tableau de l'univers et des corps organises* (Palerme, 1815), and find that the name *Euryurus* is given merely in a list of generic names. There is no description, no reference to a description, and no specific name cited, and the name may be regarded a *nomen nudum*. According to the International Rules of Zoological Nomenclature, generic names of this nature may be, if properly proposed, used again for other forms by later workers. *Eutheatus* in consequence was proposed without justification, it becomes a junior synonym of *Euryurus* Koch, 1847.

Genus **Amplinus** Attems

Amphinus (*sic*) Attems, Denk. Akad. Wien **68**: 281, 396. 1899 (as subgenus of *Pachyurus*).
Polylepiscus (in part) Attems, Das Tierreich **69**: 300. 1938 (not *Polylepiscus* in the sense of Pocock 1909).
Phinotropis Chamberlin, Bull. Amer. Mus. Nat. Hist. **78**: 499. 1941.—Hoffman, Proc. U. S. Nat. Mus. **102**: 239. 1951 (type, *Phinotropis tidus* Chamberlin).

Type.—*Pachyurus* (*Amplinus*) *kalonotus* Attems, by designation of Pocock, 1909.

Diagnosis.—A euryurid genus characterized as follows: head with prominent subantennal swellings, collum as wide as second segment, tergites with prominent quadrate areas, telson broadly quadrate in shape, preanal scale subacuminate or rounded and with very small lateral setiferous tubercules.

Male gonopods with elongate trachial rods, coxae somewhat rounded-elongate, prefemur and femur fused into a short, straight trunk, a long slender solenomerite and an elongage laminate tibiotarsus are set off from the femur by a perceptible joint.

Range.—Upper Amazonian basin, in western Brazil, eastern Ecuador, and northeastern Peru.

Species.—Five, listed in my 1951 paper under *Phinotropis*.

Remarks.—As originally proposed, *Amplinus* included six species: *Pachyurus kalonotus* Attems and *P. acuticollis* Attems, *Polydesmus klugii* Brandt, *P. erichsoni* Brandt, *P. abstrusus* Karsch, and *P. ater* Peters. No type species was designated. In 1909 Pocock selected *kalonotus* as type, and added six more species from Central America to the genus. But within the genus as understood by Pocock there were representatives of two different groups. In one of them (including *kalonotus*, *acuticollis*, and presumably *ater*) the preanal scale is of the usual polydesmoid form—subtriangular to semicircular. In the other group,

however, it is trapeziform in shape, that is to say, distally truncate instead of acute or rounded, with the caudal margin parallel to the basal edge and with the lateral setiferous tubercules considerably enlarged. This difference has come to be unanimously regarded by students of diplopods as one of generic value. It is very unfortunate that the name *Amplinus* has been misapplied, by all workers subsequent to Pocock, to the group having the truncate or concave preanal scale.

In his most recent treatment of the polydesmoids (Das Tierreich, Lief. 68–70) Attems erroneously cites *Polydesmus klugii* of Brandt as type of *Amplinus*, and, moreover, places *kalonotus* and its relatives in Pocock's genus *Polylepiscus*. That this association is untenable taxonomically as well as nomenclatorially is evidenced by differences in the gonopods of the various species involved. The Guatemalan species included by Pocock in *Polylepiscus* have, in addition to the spiculiform solenomerite, a somewhat similar branch from the base of the tibiotarsal blade. The South American species under consideration lack this additional process, and the tibiotarsus of their gonopods is also longer and more sinuate. Realization that they could not be properly placed in *Polylepiscus* induced me to group them under Chamberlin's name *Phinotropis*, based upon *P. tidus*—a Peruvian species which is obviously congeneric with *kalonotus*. So the discovery that *kalonotus* is the true type species of *Amplinus* requires relegation of *Phinotropis* to the status of a junior synonym, and proposal of a new generic name for the Central American species heretofore called *Amplinus*. In reference to its mistaken identity, the group may be called

Pseudamplinus, n. gen.

Type.—*Amplinus orphinus* Chamberlin 1922, by present designation.

Diagnosis.—A euryurid genus characterized as follows: head with prominent subantennal swellings, collum as wide as second tergite, tergites strongly tesselated in most species, telson broadly truncate distally and quadrate in appearance, preanal scale trapeziform in shape with the lateral setiferous tubercules very large and the margin between them straight or concave.

Male gonopods with very long slender trachial rods; coxae rather slender; prefemora and femora fused into a straight trunk; a slender blade-like solenomerite and a thin flattened tibiotarsal branch, both directed at nearly a right angle to the femoral portion, are set off from this by a perceptible joint or suture, both of these terminal elements are directed away from the coxal joint.

This is the only genus of the family having the truncate or distally concave preanal scale which is so characteristic of the Platyrhacidae, and may be regarded as a sort of intermediate group. In the form of the keels, however, the relationship is clearly with the other euryurids.

Range.—Middle America, from southern Mexico (Guerrero and Vera Cruz) south to Costa Rica, and also northwestern Venezuela. Most of the species occur in Guatemala and in Vera Cruz.

Species.—23, as follows: *abstrusus* (Karsch), *areatus* (Pocock), *armatus* (Pocock), *beebei* (Chamberlin), *convexus* (Carl), *crenus* (Chamberlin), *eutypus* (Chamberlin), *erichsoni* (Brandt), *flavicornis* (Pocock), *klugii* (Brandt), *leon* (Chamberlin), *manni* (Chamberlin), *niteus* (Chamberlin), *nitidus* (Brolemann), *orphinus* (Chamberlin), *palicaudatus* (Attems), *pococki* (Cook), *schmidti* (Chamberlin), *tajumulco* (Chamberlin), *tapachulae* (Chamberlin), *triramus* (Pocock), *xelitus* (Chamberlin), *zuniulus* (*sic*) (Chamberlin).

Remarks.—Inasmuch as no members of this genus have yet been collected in Panama, the presence of two rather similar forms in northwestern Venezuela is of some interest. These species, *abstrusus* and *beebei*, agree with each other and differ from other members of the genus in having a rather shortened solenomerite. Karsch's type came from Puerto Bello, Chamberlin's from Rancho Grande, about 35 miles to the south. The similarities between the two suggest synonymy, or at best a subspecific relationship.

Redescription of several poorly known species, based upon material in my possession, is planned for inclusion in my forthcoming revision of this genus.

Although Pocock clearly disposed of the mystery surrounding the matter of the type species of *Orthomorpha*—designating *Polydesmus beaumonti* Le Guillou following the elimination of all other species from the genus *Paradesmus* by Saussure, a remarkable effort was made by Cook in 1911 to restrict the name *Orthomorpha* to members of the present genus! But Cook's proposal was based upon a highly subjective line of reasoning having absolutely no basis in fact, and no subsequent writer has ever discussed or even referred to it. The matter, in brief, may be summarized as follows: in 1859 the genus *Paradesmus* was erected by Saussure for five species

distributed in three groups. The first contained only *Polydesmus carolinensis*, the second *P. klugii*, *P. erichsoni*, and *P. picteti*, and the third only *P. beaumonti*. As Pocock pointed out, one of these five species must be the type, the addition of *coarctatus* in 1860 having no bearing on the question. In 1869 Humbert and Saussure provided the name *Euryurus* of Koch for *carolinensis*, and *Pachyurus* for the three species of the second group, leaving *beaumonti* as the only species in *Paradesmus*. Cook observed that since Saussure had implied in 1859 that *beaumonti* was not a typical member of the genus *Paradesmus* (in the sense that it differed considerably from the other species), that generic name, and its replacement *Orthomorpha*) should be properly applied to the members of the second group—*klugii*, *erichsoni*, and *picteti*.

On the other hand, Cook also pointed out that the species described and illustrated as *klugii* by Pocock in the Biologia differed in several respects from the type specimen of the species, which he had seen in the Berlin Museum, and suggested the name *pococki* for the form treated in the Biologia as *klugii*. Cook's perception of specific differences was a good one, and it may be reasonably admitted that he was correct in this particular. I therefore list *pococki* in the roster of species given above. It is to be hoped that material from Alvarado, Vera Cruz (the type locality of *klugii*) will soon be forthcoming to permit a final settlement of the confusion which surrounds application of the name.

Genus **Polylepiscus** Pocock

Polylepiscus Pocock, Biologia Centrali-Americana, Chilopoda and Diplopoda: 154. 1909.
Euplinus Chamberlin, Ann. Ent. Soc. Amer. **45**: 578. 1952 (type: *E. volcanicola* Chamberlin, by original designation).

Polylepiscus appears to be a genus more or less endemic to the Guatemalan plateau, and individuals seem to be scarce, to judge from the few preserved in museum collections. It is noteworthy that no additions to the genus have been made since Pocock's original description and account in the Biologia[1]. It is to that reference, therefore, that appeal must be made for information pertinent to the allocation of the new forms.

Pocock found that the genus was divisible into two groups on the basis of several correlated structural features. The following key is based upon that presented by him, with a few changes.

KEY TO THE KNOWN FORMS OF POLYLEPISCUS

1. Pores of 19th segment completely lateral; metatergites smooth or nearly so, polygonal areas well-defined or obsolete but not obscured by granulation of dorsum.....2
   Pores of 19th segment on dorsal side of keels; dorsum rugulose or granular, the polygonal areas obscured.....4
2. Dorsum entirely smooth, no trace of areas except a few vaguely defined on keels; a middorsal row of large oval spots present *trimaculatus*, n. sp.
   Dorsum with polygonal areas well defined; no middorsal row of spots.....3
3. Polygonal areas smooth, not tubercular, except obscurely so on the keels *stolli* Pocock
   Polygonal areas manifestly tubercular *furcifer* Pocock
4. Keels of posterior half of body with anterior border basally produced, posterior border from 13th to 18th distinctly shouldered at base, 19th tergite granular *actaeon* Pocock
   Keels of posterior half of body with anterior border less produced; posterior border strongly concave, not shouldered, 19th tergite granular only posteriorly or smooth. 5
5. Tibiotarsus of male gonopod less curved, not crossing behind tip of tibiotarsal process; 19th tergite granular over posterior half *h. heterosculptus* Carl
   Tibiotarsus of male gonopod more acutely bent, in mesial aspect crossing behind tip of tibiotarsal process; 19th segment almost entirely smooth.....*h. pococki*, n. subsp.

It is to be especially noted that, with the exception of *stolli* (from Cholhuitz, Guatemala), the previously known species have not been recorded from any definite locality. A considerable amount of work thus remains to be done in the way of defining the ranges of the different forms. Material of *trimaculatus*, on the other hand, has been obtained at several localities; and *heterosculptus pococki* is here described from northeastern Chiapas, extending the known range of the genus slightly outside the political limits of Guatemala.

Polylepiscus furcifer Pocock

Polylepiscus furcifer Pocock, Biologia Centrali-Americana, Chilopoda and Diplopoda: 156, pl. 12, figs. 1–1h. 1909.

[1] *Euplinus volcanicola* has recently been described as a new genus and species and was contrasted only with *Amplinus* in the generic diagnosis. One can never understand why *Polylepiscus*, beautifully illustrated and thoroughly described in the Biologica, was not taken into consideration. Not only is *Euplinus* a junior generic synonym, but furthermore I can not see how *volcanicola* differs in any respect from *P. furcifer* Pocock.

Euplinus volcanicola Chamberlin, Ann. Ent. Soc. Amer. **45**: 578, fig. 43. 1952.

The type locality of *volcanicola*, Volcán Tajumulco, Guatemala, provides the first definite locality from which *furcifer* has been taken. Pocock's type specimen was without any locality data.

Polylepiscus trimaculatus, n. sp.

Fig. 2

Type specimen.—Male holotype, U. S. Nat. Mus. no. 2098, from Sepaciute, Guatemala, collected in March 1902 by O. F. Cook. *Allotype* a female with the same collection data.

Diagnosis.—Readily separable from the other members of this genus by the smooth dorsum, trimaculate color pattern, and configuration of the male gonopod. The lateral position of the pores allies this form with *stolli* and *furcifer*. The prefemerofemoral portion of the gonopod is proportionately smaller in relation to the tibiotarsus than in the other species of which males are known.

Description.—The general body form coincides closely with the descriptions given by Pocock. The following notes were made from the type specimens:

Length of male, 62, width, 11 mm.; length of female, 60, width, 9.5 mm. Dorsum entirely smooth except for faint indications of areas on the keels; metazonites considerably raised above level of prozonites. Keels of segments 3–19 produced caudad, their caudal margins concave and finely serrate; pores all completely lateral. Telson broadly rounded. Preanal scale subtriangular but distally rounded. Pleurites coarsely granular, with a series of acute tubercules along the caudal margins, becoming larger on the posterior segments, frequently a small cluster of spines just below the projection of the keels.

Sternites and basal segments of legs smooth and glabrous. The raised area between the leg-pairs of each segment impressed by a longitudinal and a transverse furrow, creating a small tumid area at the base of each leg. Distal segments of legs sparingly hirsute. Bases of last pair of legs almost in contact.

Gonopod aperture of male rather small and ovoid, with raised margins. Gonopods with long slender trachial rods; the coxae small and cylindrical. Basal half of telopodite densely setose. Distal half set off by a distinct groove or suture. Solenomerite long and slender, unmodified, very slightly sinuous. Tibiotarsus somewhat broader, laminate, its distal end bent at a right angle; tibiotarsal process slender, unmodified, gently curved distad toward the tibiotarsus.

Color of the preserved specimens as follows: dorsum chocolate brown to blackish; underparts light brown to tan. All of the upper surface of the keels and a large ovate median spot on each segment lighter. Collum with an hourglass-shaped mark. A label with the specimens reads "Spots, carinae, legs, and antennae pale grayish, nearly white", this presumably referring to the condition in life.

Remarks.—Additional material of *trimaculatus* has been seen from the following localities: GUATEMALA.—Pancajche, several taken in May 1905 by G. P. Goll; Trece Aguas, April 21, 1906 and June 1907 by O. F. Cook (all U. S. N. M.).

Polylepiscus heterosculptus pococki, n. subsp.

Fig. 1

Type specimen.—Adult male holotype, U. S. Natl. Mus. no. 2099, from Tumbala, State of Chiapas, Mexico, collected on June 20, 1906, by O. F. Cook.

Diagnosis.—Very similar to *P. h. heterosculptus*, from which it may be distinguished by the contrasting features given in the following couplet:

Size large, length 80–90 mm, width, 13–15 mm; dorsum with conspicuous transverse rows of tubercules; caudolateral corners of keels of segments 5–16 produced caudally; keels, legs, and antennae reddish brown to blackish brown; 19th tergite granular posteriorly; tibiotarsus of male gonopod slender, distally recurved away from the solenomerite
h. heterosculptus Carl

Size smaller, length 60–65 mm, width, 9–11 mm, dorsal rows of tubercules less pronounced; caudolateral corners of keels of segments 4–16 produced caudad; legs, antennae, and keels yellowish; 19th tergite entirely smooth; tibiotarsus of gonopod heavier, crossing behind tip of solenomerite....*h. pococki*, n. subsp.

With the foregoing exceptions, *pococki* agrees so well with the excellent description of *heterosculptus* given by Carl that a description of my type series seems unnecessary. The differences between the two forms, while not impressive singly, are sufficient when taken in combination to warrant separation of a new subspecies. It is to be regretted that we are ignorant of the provenance of Carl's material.

This form is named in recognition of R. I. Pocock's outstanding contribution to our knowledge of the diplopod fauna of Central America.

Genus **Colomborus** Chamberlin

Colomborus Chamberlin, Ann. Ent. Soc. Amer. **45**: 587. 1952.

Type.—*Colomborus martanus* Chamberlin (= *Pycnotropis colombiensis* Chamberlin, 1923).

Range.—Colombia.

Species.—1.

Remarks.—There is no doubt that the type of this genus is worthy of systematic recognition. It is interesting to note, however, that *Colomborus* was proposed as a monotypic genus based upon a new species, despite the fact that this species had obviously already been described. One must presume that Chamberlin, in working up the material for his 1951 paper, did not even take into consideration his own earlier (1923) contribution on the millipeds of Colombia in which the species was first recognized under the name *Pycnotropis colombiensis*. I am unable to discern any specific differences in the illustrations of the male genitalia (1923: fig. 112; 1952: fig. 42).

Genus **Protaphelidesmus** Brolemann

Protaphelidesmus Brolemann, Ann. Soc. Ent. France **84**: 559. 1915—Attems, Das Tierreich **69**: 313. 1938.—Hoffman, Proc. U. S. Nat. Mus. **102**: 240. 1951.

Ptyxogon Chamberlin, Bull. Amer. Mus. Nat. Hist. **78**: 500. 1941.—Hoffman, Proc. U. S. Nat. Mus. **102**: 240. 1951 (type: *P. incus* Chamberlin, by original designation).

Type.—*Platyrrhacus ligula* Brolemann.

Range.—Venezuela; northeastern Peru.

Species.—3: *ligula* Brolemann, *incus* Chamberlin, *levigatus* Attems.

Remarks.—Since completing my first paper on this group, in which *Ptyxogon* was held distinct on the basis of smooth tergites, I have carefully reconsidered the drawings and descriptions of all three of the species involved, as well as the type of *P. incus*, and no longer believe that two genera can be recognized. Jeekel, writing on East Indian strongylosomoids, has recently emphasized the intrageneric variability of body form, and reiterated the primary importance of the male gonopods. I have reached the same conclusions from recently acquired familiarity with several groups of tropical diplopods. The sculpture of the tergites, without substantiating genital features, can scarcely be considered of generic value.

Genus **Seminellogon** Chamberlin

Seminellogon Chamberlin, Pan-Pacific Ent. **9** (1): 18. 1933.

Type.—*S. chitarianus* Chamberlin, by original designation.

Range.—Costa Rica; Panama.

Species.—2: *chitarianus* Chamberlin, *cerro-azulensis*, n. sp.

Remarks.—This genus was overlooked in the preparation of my previous paper, primarily because it was described as being closely related to *Aphelidesmus* and thus listed by Attems in 1937 amongst the "unsichere Gattungen" of the Strongylosomidae. *Seminellogon* is of course a euryurid, and very close to *Amplinus*, into which it and several others may have to be withdrawn. A possible generic character, of unproven value, is the location of the pores on the *under side* of the keels of the 18th and 19th segments. In this respect it differs from the Central American genera, but I have not been able to study the South American forms in this respect.

Seminellogon heretofore has been monotypical. A new species is here described from the high mountains of northwestern Panama, and based upon fairly large and homogeneous series. Considering the quality level of the differences, however, it would not be surprising if the new form is later shown to be a subspecies of *chitarianus*.

Seminellogon cerroazulensis, n. sp.

Fig. 3

Type specimens.—Male holotype, U. S. Nat. Mus. no. 2100, from Cerro Azul, Province of Chiriquí, Panama, collected on March 26, 1911, by E. A. Goldman. Male and female paratypes from Boquete, Chiriqui Province, Panama, January 1940, W. C. Wood (Amer. Mus. Nat. Hist. A-7175) and from El Volcán, Chiriquí Province, Panama, February 28, 1936, W. J. Gertsch (Amer. Mus. Nat. Hist.).

Diagnosis.—Differing from *S. chitarianus* primarily in the characters of the male gonopod, such as the longer and less curved solenomerite; the much more slender tibiotarsus with a prominent broadening near its base; and the distinctly shorter basal, setose, portion of the telopodite.

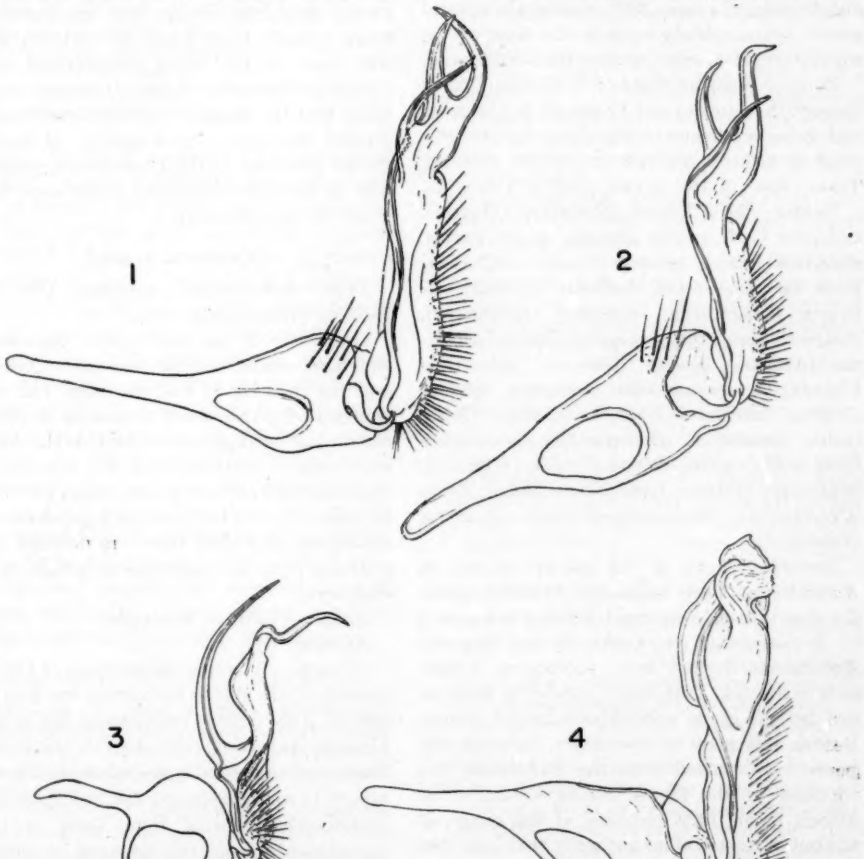
Description.—Agreeing in most respects with the description of *chitarianus* given by Chamberlin. The following specific notes were made from the type specimen.

Length, 44, width, 6 mm. Dorsum, sides, and ventral surfaces all entirely smooth and shining, no evidence of granulation or other roughening. Front edge of keels not shouldered, but forming an even arc back to the caudolateral corner.

Latter very little produced except on the last few segments. Caudal margin of keels nearly straight, not concave or shouldered basally. Pores lateral on all keels except the 18th and 19th, where they are distinctly inferior, on the under side. Telson almost square, with rounded corners, but slightly longer than broad. Sternites not distinctly impressed, nor lobed at the bases of the legs.

Male gonopod (Fig. 3) with a short slender tracheal rod; coxa rather globose and large in proportion to the rest of the gonopod; prefemur-femur short, heavily setose, its front margin produced into a flange overlapping most of the course of the seminal channel. Tibiotarsus set off by a conspicuous suture, its basal half broad and laminate with a conspicuous lobe on one side, distad of which it becomes abruptly more slender and sigmoidally bent, tapering gradually to its tip. Solenomerite very long, almost length of tibiotarsus, gently curved and gradually tapering distad, without branches or other modifications.

Dorsum light brown with the keels and a large trapeziform area in the middle of each metatergite yellow, the latter giving the effect of a continuous, broadly serrate median dorsal band. Prozonites entirely yellow. Color of legs, sternites, and antennae probably also yellow in life.



FIGS. 1-4.—1, *Polylepiscus heterosculptus pococki*, n. subsp., left gonopod of paratype, Tumbala, Chiapas; 2, *P. trimaculatus*, n. sp., left gonopod of holotype, Sepaciute, Guatemala; 3, *Seminellogon cerroazulensis*, n. sp., left gonopod of holotype, Cerro Azul, Panama; 4, *Varyomus confluens* (Chamberlin), left gonopod of male holotype, Rancho Grande, Venezuela. All figures to same scale, showing gonopod in mesial aspect.

Genus **Aphelidesmus** Brolemann[2]

Aphelidesmus Brolemann, Ann. Soc. Ent. France **67**: 322. 1898; Ann. Soc. Ent. France **84**: 584. 1915—Carl, Mem. Soc. Neuchat. Sci. Nat. **5**: 936. 1914—Attems, Rev. Zool. Bot. Afr. **17**: 280. 1929; Das Tierreich **68**: 128. 1937.

Type.—*A. hermaphroditus* Brolemann, by original designation.

Diagnosis.—A genus of the Euryuridae in which the tibiotarsus of the male gonopod is generally elongated and considerably expanded-laminate, forming a shield-like or spathe-like arrangement which partially or entirely encloses the long slender solenomerite. Femur of gonopod distally rotated almost 360°, causing the seminal groove to completely encircle the base of the tibiotarsus before entering upon the solenomerite.

Range.—From the State of Pará, Brazil, north through the Guianas and Venezuela to Colombia and Ecuador, thence north along the Atlantic coast of Central America to extreme southern Texas. Most of the species occur in Colombia.

Species.—29, as follows: *albocarinatus* (Peters), *ambiguus* Carl, *areatus* (Peters), *asper* Attems, *aterrimus* Attems, *atratus* (Pocock), *bellus* Attems, *convexus* Jeekel, *dealbatus* (Gervais), *divergens* (Chamberlin), *elongatus* (Brolemann), *frangens* Chamberlin, *fumigatus* (Peters), *glaphyros* (Attems), *goudoti* (Gervais), *guianiensis* Chamberlin, *hermaphroditus* Brolemann, *hybridus* (Peters), *intermedius* Chamberlin, *major* Chamberlin, *octocentrus* (Brolemann), *panamanicus* Chamberlin, *rivicola* (Silvestri), *roulini* (Gervais), *semicinctus* (Peters), *surinamensis* Jeekel, *tertius* (Chamberlin), *tripunctatus* (Peters), *uncinatus* (Peters).

Remarks.—Many of the species referred to *Aphelidesmus* were originally described under the generic name *Euryurus* (including two named by Brolemann six years after he had proposed *Aphelidesmus*!); and most subsequent writers such as Pocock, Carl, and Chamberlin have associated the genus with other euryurid groups. Despite this body of precedence, however, the genus was removed from the Euryuridae and relocated in the family Strongylosomidae by Attems in his 1929 summary of the group. It was out of respect of his authority that I omitted *Aphelidesmus* from my 1951 paper. Later consideration has convinced me that Attems was in error, an opinion which is shared by my colleague C. A. W. Jeekel, who has worked upon both *Aphelidesmus* and many strongylosomoid genera from Asia. Mr. Jeekel suspects that Attems may have been influenced primarily by the elongated and partly concealed solenomerite of *Aphelidesmus* species. In other respects, including the two cited as diagnostic of the Strongylosomidae by Attems (i.e., median constriction of the gonopod aperture and independence of the gonopod coxae) these species do not qualify as stronglylosomid.

This is the largest genus in the Euryuridae, there being some 29 species (many of which are known only from female type specimens); the range extends from Texas to northern Brasil, with most of the forms concentrated in the Colombia-Venezuela region. It seems not unlikely that the group as here comprised may be divided into two or more genera. At least one species described in the genus is not congeneric with *A. hermaphroditus*, and a new name is proposed for its accomodation.

Varyomus, n. gen.[3]

Type.—*Aphelidesmus confluens* Chamberlin 1950, by present designation.

Diagnosis.—A euryurid genus characterized as follows: similar in most respects to *Aphelidesmus* but differing in that the distal half of the gonopod telopodite is not twisted on its axis, and the seminal canal proceeds directly to the solenomerite without first encircling the gonopod. The solenomerite itself is long and slender and distally protected by several laminate expansions of the tibiotarsus, but even these are different in appearance from the analogous structures in *Aphelidesmus*.

Range.—Northern Venezuela.

Species.—One.

Remarks.—Through the kindness of Dr. W. J. Gertsch, I was able to re-examine the type specimen of *Aphelidesmus confluens* in the American Museum collection, and provide herewith an illustration of the left gonopod as seen in mesial aspect. It will be apparent that the appendage is considerably different from those of typical Aphelidesmids, and this situation is additional evidence of the futility of drawing gonopods from whatever position happens to be convenient.

[2] *Trachelorhacis* Silvestri 1898, which has three months priority over *Aphelidesmus* as a name for this genus, is a junior primary homonym of *Trachelorhacis* Agassiz, 1846.

[3] Named for Dr. Ralph Vary Chamberlin, the describer of perhaps the majority of American milliped species.

SUMMARY

It now appears that three groups can be discerned amongst the American genera of the Euryuridae (perhaps the Oriental genera, of which I have not seen material, belong to still another) as reflected by various trenchant differences in the male genitalia. Two of these have already been recognized by Brolemann, as long ago as 1915, who set *Aphelidesmus* and *Protaphelidesmus* apart in a separate subfamily which he called Aphelidesminae. His arrangement of the platyrhacoid diplopods was as follows:

Family Platyrhacidae
Subfamily Platyrhacinae
Tribe Platyrhacini
Tribe Euryurini
Subfamily Aphelidesminae

It will be noted that the Aphelidesminae was given a rank equivalent to what would now be regarded as a superfamily including the Platyrhacidae and Euryuridae (a position which I believe in the light of present knowledge to be too exalted). That Silvestri was equally impressed by the characters of his synonymical genus *Trachelorhacis* is evidenced by the new family which he proposed for the reception of *T. rivicola*.

In admitting that the distinction generally accorded *Aphelidesmus* is probably well-founded, one has to recognize that as much or more difference obtains between *Euryurus* and *Amplinus* as between those two genera on one hand and *Aphelidesmus* on the other. Giving these differences a coordinate degree of recognition requires the establishment of a third subfamily. These groups may be distinguished and diagnosed as follows:

KEY TO THE SUBFAMILIES OF EURYURIDAE

1. Tibiotarsus of male gonopod substantially expanded into a broad sheath, which shields or actually encloses solenomerite branch and which often has one or more small processes of its own
Subfamily I. Aphelidesminae Brolemann
Tibiotarsus of male gonopod generally long (reduced in one genus), very seldom broadened, never forming a protective element for solenomerite (when one is present).....2
2. No definite solenomerite present; telopodite of gonopod simple, tibiotarsal joint not set off by a conspicuous articulation
Subfamily II. Euryurinae, n. subf.[4]
A long slender solenomerite present, arising at base of tibiotarsus; telopodite of gonopod with a definite joint or line of separation between femur and tibiotarsus
Subfamily III. Amplininae, n. subf.

The genera belonging to these groups may be in turn separated by the following keys:

KEY TO THE GENERA OF THE APHELIDESMINAE

1. Tibiotarsus of gonopod twisted almost 360° on axis of telopodite, seminal canal making a complete circuit around gonopod before entering on solenomerite, latter concealed or partly enclosed by tibiotarsus, which forms a sheath.....*Aphelidesmus* Brolemann
Tibiotarsus of gonopod not rotated on its axis; seminal canal running directly to solenomerite; latter not shielded or concealed by tibiotarsus.....2
2. Solenomerite short, upright, arising from near base of tibiotarsal blade; latter without secondary processes
Protaphelidesmus Brolemann
Solenomerite long, arising from middle of femoral portion of gonopod; tibiotarsal portion composed of two laminate processes which conceal tip of solenomerite
Varyomus Hoffman

KEY TO THE GENERA OF THE EURYURINAE

1. Gonopod relatively long and slender, tibiotarsal portion present and with a small subterminal process.....*Euryurus* Koch
Gonopod short and robust, tibiotarsal portion rudimentary, represented only by a short digitiform lobe.....*Auturus* Chamberlin

KEY TO THE GENERA OF THE AMPLININAE

1. Preanal scale distally truncate or concave, lateral tubercules large (23 species)
Pseudamplinus Hoffman
Preanal scale subtriangular or broadly rounded, the lateral tubercules very small or absent..2
2. No subantennal swellings present (9 species)
Pycnotropis Carl
Prominent subantennal swellings present....3
3. Male gonopods with a secondary tibiotarsal process in addition to the larger main blade; caudolateral corners of the keels rather prolonged into spiniform processes (5 species)
Polylepiscus Pocock
Male gonopod without a secondary tibiotarsal branch.....4
4. Femoral portion of gonopod very stout and short, exceeded in length by the correspondingly elongated solenomerite.....5

[4] This name is proposed as new, being much more limited in its scope than Euryurinae as used by Pocock in the Biologia.

Femoral portion of gonopod long and slender, exceeding the solenomerite and often tibiotarsus in length 7

5. Tibiotarsus of gonopod generally slender, unmodified, distally acuminate (2 species)
Seminellogon Chamberlin

Tibiotarsus of gonopod distally modified 6

6. Tibiotarsus slender, parallel-sided, bladelike, bifid distally (8 species)
Thrinoxethus Chamberlin

Tibiotarsus broadly sigmoid, widest at midlength, distally trifid (1 species)
Sigmogonotropis Hoffman

7. Tibiotarsus generally distally acuminate, occasionally expanded but never with spinous processes or teeth (5 species)
Amplinus Attems

Tibiotarsus broadened, blade-like with a conspicuous process at its midlength and several small subterminal teeth (1 species)
Colomborus Chamberlin

Of the genera admitted to this key, there is considerable uncertainty in my mind concerning the status of the last five enumerated. Very little in the way of annectant forms would be required to necessitate consolidation of all of these nominal genera back into *Amplinus*. For the time being, however, they appear to be reasonably discrete and easily recognizable groupings; the gonopods being more distinctive than one would appreciate from the inadequate characterizations in the key.

In addition to the pores of the 18th and 19th segments of *Seminellogon*, another character of unestablished taxonomic value is the presence or absence of subantennal swellings. I have never seen any specimens of *Pycnotropis*; the information regarding this difference is derived from Attems. Considering the fallability of other characters employed in that author's key to the euryurid genera, this one must be held in suspicion until it has been more thoroughly investigated.

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MALACOLOGY.—Leiostracus (?) kugleri, *n. sp., a new bulimulid mollusk from Venezuela.* LOTHAR FORCART, Museum of Natural History, Basle, Switzerland. (Communicated by Harald A. Rehder.)

Since 1922 Dr. H. G. Kugler and other Swiss geologists have been sending most interesting scientific collections from Venezuela and Trinidad to the Museum of Natural History in Basle (Switzerland). During the war, 1939–1945, when normal communications between South America and Switzerland were interrupted, Dr. Kugler sent malacological collections from Venezuela to the U. S. National Museum in Washington. Dr. H. A. Rehder recently entrusted this material to the author for determination. Shells of a species of Bulimulidae were identified with those the Museum in Basle received as early as 1926, and of which the revision established that they belong to a species hitherto undescribed. The species is dedicated to Dr. H. G. Kugler, to whom science owes much for the scientific exploration of Venezuela and Trinidad.

Leiostracus (?) kugleri, n. sp.

Diagnosis.—The shell is solid, elongate-turriculate, narrowly umbilicated; its color is white with ochraceus stripes, which are faded in worn shells; the apical whorls are yellowish to whitish.

The nepionic whorls are almost smooth; the following whorls have more or less distinct irregular riblets.

The aperture is elongate-ovate, its base somewhat angular. The columellar lip is expanded with a straight vertical edge. The internal part of the aperture and the expanded lip are brownish colored.

The shells show nearest morphological relations to those of *Leiostracus cinnamomeo-lineata* (Moricand) from the Brazilian Province Bahia, of which paratypes (Mus. Basle 1489-a) have been compared.

FIG. 1.—*Leiostracus* (?) *kugleri*, n. sp.: Holotype, ×2 and natural size.

Holotype.—Mus. Basle 4950-a.

Type locality.—Venezuela, Est. Falcón, Distr. Colina, Porta Juela near Cumarebo—leg. Dr. H. G. Kugler and Dr. L. Vonderschmitt 1926.

77 paratypes.—8 (Mus. Basle 4950-a′) from the type locality; 36 (Mus. Basle 4950-c and 4950-d) and 27 (U. S. Nat. Mus. 508834 and 508855) from Est. Falcón, Distr. Zamora, Cumarebo Field—leg. Dr. H. G. Kugler 1933–1949; 6 (Mus. Basle 4950-b) from Est. Falcón, Distr. Acosta, near Río Tocuyo—leg. Dr. H. G. Kugler, 1929.

Measurements of the shell (in mm).—As follows:

Specimen	Diameter	Height	Aperture		Number of Whorls
			Width	Height	
Holotype (Mus. Basle 4950-a)	7.5	20	4.1	7.8	8⅛
Paratype (Mus. Basle 4950-a′)	9.4	25.7	5.9	9.5	8⅛
Paratype (U.S. Nat. Mus.)	8.3	22.1	3.6	8.9	8⅛

Because only shells of this species are knowns its classification in the genus *Leiostracus* Albers, 1850, is based only on conchological feature.,

PROCEEDINGS OF THE ACADEMY

462D MEETING OF THE BOARD OF MANAGERS

The 462d meeting of the Board of Managers, held in the Library of the Cosmos Club on March 16, 1953, was called to order by the President at 8 P.M., with the following in attendance: F. M. SETZLER, F. M. DEFANDORF, J. R. SWALLEN, H. S. RAPPLEYE, J. A. STEVENSON, A. G. MCNISH, W. H. GILBERT, F. W. POOS, H. A. BORTHWICK, C. A. BETTS, A. H. SCOTT, L. A. SPINDLER, F. W. HOUGH, SARA E. BRANHAM, W. W. DIEHL, and, by invitation, E. H. WALKER, KARL HERZFELD, W. W. RUBEY, and J. C. EWERS.

In the absence of Chairman DAVIS of the Committee on Meetings, Mr. Setzler reported that Dr. Gordon Macgregor, of the Technical Cooperation Administration, Department of State, would speak at the April meeting of the Academy.

Dr. RUBEY, Chairman of the Policy and Planning Committee, reported informally that the Committee unanimously approved the affiliation of the Washington Section of the International Association for Dental Research. The report was accepted by the Board. Dr. RUBEY also reported that four members of the Committee thought the appointment of a special committee to consider ways and means of improving the JOURNAL was not desirable, but suggested that the Board of Editors review the reports of the past 10 years in this connection and bring recommendations to the Board of Managers; one favored the appointment of a special committee; and one was noncommital. After a brief discussion to the effect that the report leaves the subject as it was before, the question was set aside pending a formal report of the Committee.

In the absence of Chairman MCPHERSON, Mr. SETZLER reported that the Committee on the Encouragement of Science Talent had arranged a dinner at the Cosmos Club on March 17 for 17 persons, including counselors from Washington, Maryland, and Virginia, members of P.T.A. councils, members of engineering groups, and the President, to build up enthusiasm with P.T.A. organizations in the metropolitan area in

junior high schools as well as in senior high schools, not only among the students, but also the parents, with a view toward contributions to defray expenses of the Science Fair.

The Secretary reported the death of CHARLES MOON on January 31, 1953.

The result of the ballot vote for the affiliation of the Washington Chapter, American Society for Metals was announced. A total of 406 ballots were returned, of which 399 approved affiliation, 5 were against, and 2 were blank.

The Treasurer read a letter from EUBANKS CARSNER requesting to be placed on the retired list. The request was approved.

The Treasurer reported that $745 had been received in 1952 and 1953 for the Science Fair Fund. With the $200 contributed by the Academy, a total of $945 was available. Deducting bills already paid, partly for the 1952 Fair, there is a balance of $736.20 for the 1953 Fair.

Further consideration was given to the purchase of a motion-picture projector for the Assembly Hall of the Cosmos Club. It was brought out that six of the affiliated societies held their meetings there: Botanical Society of Washington, Philosophical Society of Washington, Geological Society of Washington, Washington Society of Engineers, and the District of Columbia Section, American Society of Civil Engineers. Since only these societies would be concerned, it was suggested that a special committee be appointed consisting of the Vice Presidents of these societies and the Treasurer of the Academy.

463D MEETING OF THE BOARD OF MANAGERS

The 463d meeting of the Board of Managers, held in the Library of the Cosmos Club on April 13, 1953, was called to order by the President at 8 P.M. with the following in attendance: F. M. SETZLER, F. M. DEFANDORF, J. R. SWALLEN, H. S. RAPPLEYE, J. A. STEVENSON, A. G. McNISH, H. A. BORTHWICK, G. F. GRAVATT, C. A. BETTS, L. A. SPINDLER, M. A. MASON, SARA E. BRANHAM, R. G. BATES, W. W. DIEHL, and, by invitation, WATSON DAVIS, W. N. FENTON, KARL HERZFELD, W. W. RUBEY, and A. T. MCPHERSON.

President SETZLER announced the appointment of a special committee to determine the advisability of the Academy and its Affiliated Societies purchasing a modern arc-equipped motion-picture projector and presenting it to the Cosmos Club for use in the Assembly Hall. The members of the committee are: CLIFFORD A. BETTS (Chairman); I. C. GARDNER, Philosophical Society; A. NELSON SAYRE, Geological Society of WASHINGTON; HARRY A. BORTHWICK, Botanical Society of Washington; MARTIN A. MASON, District of Columbia Section, American Society of Civil Engineers; and HOWARD S. RAPPLEYE, representing the Academy.

Dr. JOHN G. THOMPSON, nominated for Vice President representing the Washington Chapter, American Society for Metals, recently affiliated with the Academy, was elected.

Chairman DAVIS, of the Committee on Meetings, announced that LYNN POOLE, Director of Public Relations, Johns Hopkins University, would present an illustrated lecture on *Science in television* at the May meeting of the Academy.

Chairman FENTON, of the Committee on Monographs, reported on the progress of the index to the JOURNAL.

A. T. MCPHERSON, Chairman of the Committee on Encouragement of Science Talent, announced that the Seventh Annual Science Fair would be held from April 30–May 3, at American University. Winners in grades 9–12 will automatically become members of the Junior Academy. He also reported that a total of $955 had now been received, which will probably be sufficient to cover the cost of the Fair.

The following interim report of the special committee appointed to consider the purchase of a motion-picture projector, was presented by the Chairman, CLIFFORD A. BETTS:

The matter of the proposed purchase of a modern arc-type 16-mm motion-picture projector by the Academy and those of its affiliated societies which use the Cosmos Club Assembly Hall has been investigated by the committee. The following can be reported at this time:

1. The Board of Directors of the Washington Society of Engineers, meeting on April 1, authorized the use of its share in the slide projector which is in the Cosmos Club projection room unused because the Club has a new one.

2. The Botanical Society, through H. A. BORTHWICK, reports no funds available.

3. Pending formal confirmation by Dean MASON, it is understood that the D. C. Section ASCE has no surplus.

4. HOWARD RAPPLEYE, for the Academy, feels that the potential benefits are not commensurate with costs.

5. In deference to I. C. GARDNER, who is in Europe, and A. NELSON SAYRE whose group has not met, final report will be deferred. Prospects are not very propitious, however, for the original proposal.

Four deaths were reported by the Secretary: DOUGLAS H. CAMPBELL on February 23, 1953; THOMAS A. JAGGAR on January 17, 1953; CHARLES W. BACON on March 19, 1953; and GEORGE R. WAIT on April 9, 1953.

A letter from MAYNE R. COE was read by the Treasurer, requesting to be placed on the retired list. This was approved, effective as of December 31, 1951.

The following statement, prepared by a special committee of the Committee on Policy and Planning, was presented by the Chairman, W. W. RUBEY:

The Board of Managers of the Washington Academy of Sciences at its meeting of April 13 instructed me to transmit the following report to you.

The Board discussed the feeling of deep concern and unrest that is now widespread among scientists of Washington and elsewhere as a result of the recent dismissal of the Director of the National Bureau of Standards. The scientific and technological agencies of the Federal government have made important contributions to the health, welfare, and safety of the nation—contributions that have been possible only because these agencies have traditionally maintained an atmosphere of disinterested investigation free from political and commercial pressures. Unless this tradition is maintained, the scientific agencies will be unable to attract and retain scientists of the caliber required for the satisfactory performance of their duties.

The recent action of the Secretary of Commerce raises fundamental questions about the scientific work and administrative policies of the National Bureau of Standards. The members of the Board of Managers note with approval that Secretary Weeks has invited advice regarding the scientific performance and broader purposes of the Bureau from the Visiting Committee and from a special committee appointed by the presidents of the National Academy of Sciences and of national societies in seven fields of science and technology. In order to allay the growing concern about the future of science in Government, it is respectfully urged that the Director of the Bureau of Standards be retained in his present position until these two committees have reported, at which time it should be possible to assess the merits of the case properly.

The statement was unanimously approved by the Board with the recommendation that it be sent to appropriate persons. It was then moved and carried unanimously that the statement be sent to President Eisenhower in the form of a telegram and released to the press. It was suggested that copies of the statement be sent to DETLEV W. BRONK, President of the National Academy of Sciences, HUGH L. DRYDEN, Chairman, Interdepartmental Committee on Scientific Research and Development, members of the committee appointed by the National Academy to look into the objectives of the National Bureau of Standards, the American Association for the Advancement of Science, and the Vice Presidents of the Washington Academy.

464TH MEETING OF THE BOARD OF MANAGERS

The 464th meeting of the Board of Managers, held in the Library of the Cosmos Club on May 18, 1953, was called to order by the President at 8 P.M., with the following in attendance: F. M. SETZLER, F. M. DEFANDORF, J. R. SWALLEN, H. S. RAPPLEYE, J. A. STEVENSON, H. A. REHDER, J. P. M. MORRISON, H. A. BORTHWICK, G. F. GRAVATT, C. A. BETTS, GLEN SLOCUM, F. W. HOUGH, H. G. DORSEY, M. A. MASON, R. G. BATES, and, by invitation, E. H. WALKER, WATSON DAVIS, W. W. RUBEY, and A. T. MCPHERSON.

Chairman DAVIS, of the Committee on Meetings, announced that the October meeting of the Academy would be held at the National Institutes of Health and the November meeting would be held jointly with the Anthropological Society of Washington.

The Secretary read the following formal report of the Committee on Policy and Planning on (a) whether a special committee on improving the Journal should be appointed, and (b) whether the application from the Washington Section of the International Association for Dental Research for affiliation with the Washington Academy should be approved.

The Committee on Policy and Planning has conducted a mail ballot on these two questions and the Committee chairman has talked personally with four of the five other members.

On the second of the two questions all six members of the Committee are unanimous in recommending that the Board of Managers approve (and pass on to the Academy membership for ratification) the application from the Washington Section of the IADR for affiliation.

On the other of the two questions referred to the Committee, it is not possible to report anything like a unanimous recommendation. Two Committee members definitely recommend that a special committee NOT be appointed. One Committee member definitely recommends that a special committee SHOULD be appointed. A fourth member of the Committee weighs the pros and cons of appointing a special committee and ends up with no recommendation either way. The fifth

member ignores the question of a special committee but, from his suggestion that "the Editors print what they may find available," I judge that he considers a special committee unnecessary. This accounts for all members of the Committee except the chairman. Trying to strike a balance between these divergent recommendations, I am inclined to recommend that a special committee on improving the Journal NOT be appointed at this time but that the present editorial board be asked to review the whole problem and report to the Board of Managers not later than the first meeting next fall.

The report was accepted by the Board.

Chairman McPHERSON reported that the Science Fair held at American University from April 30–May 3, 1953, was very successful. There were 1,052 exhibits with 59 secondary schools participating. Four students were selected to represent the Washington Science Fair at the National Science Fair held at Oak Ridge May 7–9. Students have already begun work on projects for the next science fair and applications for additional space over and above that allotted this year have been received.

President SETZLER expressed his gratitude to DR. McPHERSON for his effort in connection with the Science Fair.

The Secretary reported the death of HERBERT E. GREGORY on January 23, 1952.

Senior Editor MORRISON reported a suggestion by Dr. McPHERSON, that the Washington Academy of Sciences consider a prize contest for articles for publication in the Journal, similar to that of the New York Academy of Sciences. It was pointed out, however, that the prizes awarded by the New York Academy were made from special outside memorial funds set up for the purpose, rather than from current funds of the Academy. The proposal was tabled for further study.

Dr. SETZLER, on behalf of the Board of Managers, expressed his appreciation for the assistance given by WATSON DAVIS and Science Service in preparing the telegram sent to President Eisenhower and the press release in regard to the National Bureau of Standards.

465TH MEETING OF THE BOARD OF MANAGERS

The 465th meeting of the Board of Managers, held in the Library of the Cosmos Club on October 12, 1953, was called to order by the President at 8 P.M. with the following in attendance: F. M. SETZLER, F. M. DEFANDORF, J. R. SWALLEN, H. S. RAPPLEYE, J. A. STEVENSON, J. P. E. MORRISON, A. G. McNISH, W. H. GILBERT, F. W. POOS, H. A. BORTHWICK, G. F. GRAVATT, C. A. BETTS, A. H. SCOTT, L. A. SPINDLER, F. W. HOUGH, M. A. MASON, W. W. DIEHL, J. G. THOMPSON, and, by invitation, E. H. WALKER, WATSON DAVIS, A. V. ASTIN, and A. T. McPHERSON.

In reporting on the progress of the Index to the Journal, President SETZLER stated that it was expected that it would be published in December 1953. The price was set at $7.50, with a 20 percent discount to members. This was done prior to the Board meeting in order that a notice could be carried in the October issue of the Journal which went to press on October 7. The action of the committee on the Index was approved by the Board.

Chairman DAVIS of the Committee on Meetings reported that the November meeting would be a joint meeting with the Anthropological Society of Washington and that the speaker would be Dr. CLIFFORD EVANS. Suggestions for the December meeting were requested.

The question of presenting the Awards for Scientific Achievement at the annual dinner meeting was discussed, since it was felt that holding a separate meeting for the purpose was not enough of an occasion. It was suggested that the awards might be presented at the annual meeting without responses, or responses limited to about five minutes, or the responses spread over several meetings; and that the annual meeting could be held separate from the dinner meeting. It was the opinion of the Board that there was no objection to combine the annual meeting with the dinner meeting. Dr. ASTIN said that the Committee on Awards would make specific recommendations at the next meeting of the Board.

Dr. ASTIN, Chairman of the Committee on Awards for Scientific Achievement, reported progress in selecting candidates for the 1953 awards. He brought to the attention of the Board that Dr. LYMAN J. BRIGGS would celebrate his 80th birthday next May and that special recognition would be appropriate. It was suggested that a special number of the JOURNAL might be prepared for the occasion.

In the absence of Dr. HERZFELD, Chairman of the Committee on Grants in Aid for Research, the Secretary announced that the allotment for grants from the American Association for the Advancement of Science for 1953 is $255. With a balance of $99.50 from the 1952 grant, there is a total of $354.50 available for the current year.

In the absence of Dr. RUBEY, Chairman of the Committee on Policy and Planning, the Secretary reported that the application of the Washington Section of the Institute of the Aeronautical Sciences for affiliation with the Academy, was unanimously approved by the Committee. The report of the Committee was approved by the Board.

Chairman MCPHERSON, of the Committee on Encouragement of Science Talent, stated that $1,200 would be needed for the next Science Fair. Letters were written to the Vice-Presidents requesting the support of the Affiliated Societies. KEITH JOHNSON announced that the next Science Fair would be held April 9–13, 1954, a time which would enable participating students to arrange their exhibits without missing time from school. He also stated that the Prince Georges County Science Fair was being continued, and that the Arlington Science Fair would be held prior to ours.

President SETZLER announced that bids for printing the RED BOOK had been received from two printers. The Board authorized acceptance of the lower one, from the Waverly Press. E. H. WALKER suggested reprints of the first part of the RED BOOK containing information about the Academy should be arranged for use of the Committee on Membership, and answering requests for data on the Academy.

The Secretary reported the result of the ballot vote on the application of the Washington Section of the International Association for Dental Research for affiliation with the Academy. A total of 316 votes were cast, of which 298 were for affiliation, 15 against, 2 were blank, and 1 undecided. Dr. EDWARD G. HAMPP, nominated by the Washington Section of the I.A.D.R. for Vice-President of the Academy, was elected.

The death of WILLIAM H. HOOVER on September 11, 1953, and that of ERMINE COWLES CASE on September 7, 1953, were announced.

C. S. CRAGOE, ELLIOT Q. ADAMS, and ARTHUR F. Beal requested that they be placed on the retired list. The requests were approved, effective December 31, 1952, for C. S. Cragoe and Elliot Q. Adams, and December 31, 1953, for Arthur F. Beal.

Senior Editor MORRISON reported that there was $2,823.76 remaining in the budget for the JOURNAL for the rest of the year. Since disbursements were less than the budget, the December number of the Journal will probably be enlarged to 48 pages. Sixty-two papers have already been published this year, and 40 manuscripts are on hand. Papers are placed in separate categories, and priority maintained in each category. Thus a paper in the Physical Sciences might be published in a minimum time, while one in Biology would take approximately 6 months at the present time.

A communication from the Greater Washington Educational Television Association, Inc., requesting that the Academy appoint a representative to the Advisory Council of the Association, was received. The request was referred to the Committee on Policy and Planning.

466TH MEETING OF THE BOARD OF MANAGERS

The 466th meeting of the Board of Managers held in the Library of the Cosmos Club, November 17, 1953, was called to order by the President at 8 P.M., with the following in attendance: F. M. SETZLER, J. R. SWALLEN, H. S. RAPPLEYE, J. A. STEVENSON, H. A. REHDER, W. H. GILBERT, H. A. BORTHWICK, G. F. GRAVATT, A. H. SCOTT, R. S. DILL, F. W. HOUGH, SARA E. BRANHAM, W. W. DIEHL, E. G. HAMPP, and, by invitation, HEINZ SPECHT, WATSON DAVIS, A. V. ASTIN, W. W. RUBEY, and A. T. MCPHERSON.

President SETZLER reported that final proof of the Index to the JOURNAL had been returned to the printer and publication was expected by the end of the year. He also reported that the galley proof of the Red Book has been returned to the printer, and publication was anticipated in December.

WATSON DAVIS, Chairman of the Committee on Meetings, stated that Dr. MARVIN J. KELLY, President of the Bell Telephone Laboratories, and DONALD A. QUARLES, Assistant Secretary of Defense for Research and Development, would address the Academy at the December meeting on Science in Government, and that Dr. ALAN T. WATERMAN would be the speaker at the Annual Meeting in January.

Dr. ASTIN, Chairman of the Committee on Awards, moved that the Awards for Scientific Achievement be presented at the Annual Meeting, and that the printed program include pictures and brief biographies of the recipients. The motion was carried unanimously. It was suggested that the awards be framed for presentation and the recipients requested to prepare a paper of their own choosing for publication in the Journal. It was also suggested that the President appoint an Academy Committee to consider plans for celebration of the 80th birthday of Dr. LYMAN BRIGGS.

In the absence of Dr. HERZFELD, Chairman of the Committee on Grants-in-Aid for Research, President SETZLER read the following report of the committee:

A total of $354.50 is available for the current year. Two applications (for Grants-in-Aid) have been submitted, one by Dr. HERBERT C. HANSON, Research Professor of the Department of Botany, Catholic University of America, the other by Dr. ALFRED WEISSLER.

Dr. Hanson has been studying the relationships of grassland communities to environmental conditions, particularly soils. About 200 samples of soils have been collected but analysis of the texture has to be made. This is a routine procedure but requires considerable time for so many samples. Dr. Hanson asks for $100.00 to pay student assistants for the analysis of the soil samples, tabulating and analyzing the data on the vegetation of individual stands, organizing these stands into community types and determining relationships. Dr. Hanson's project is recommended by Dr. Edward G. Reinhard, Head of the Department of Biology.

The second application comes from Dr. Alfred Weissler who is head of the Washington Office of Ordnance Research. Dr. Weissler wishes to continue on his own work in the application of ultrasonic waves to chemical problems. He has worked in this field at the National Research Laboratory before 1951 and wishes to continue it on Saturdays at the University of Maryland. Dr. Francis E. Fox of the Catholic University has placed some equipment at his disposal but he needs a transducer which the Brush Company sells for $350.00. Dr. Weissler's project is recommended by Dr. Richard K. Cook of the Sound Section at the National Bureau of Standards.

The Committee recommends as follows:

1. That a grant of $100.00 be given to Dr. Herbert C. Hanson in accordance with his request.
2. That a grant of $250.00 be given Dr. Alfred Weissler on his request, and that this grant may be used in full or in part for renting ultrasonic equipment if it should not be possible to buy it in full with the money provided or by raising additional funds.

The report was accepted by the Board.

A. T. MCPHERSON, Chairman of the Committee on Encouragement of Science Talent reported that the Academy is cooperating with the D. C. Council of Engineering and Architectural Societies in a comprehensive program for developing interest in engineering and science in the Junior and Senior High Schools of the Greater Washington area. An engineer and a scientist are assigned to each school to assist the teachers of science, to get acquainted with gifted students through science clubs, and to speak or provide speakers for school assemblies and P.T.A. meetings. A Speakers Bureau has been set up to provide speakers on special topics; it will cooperate with a speakers bureau for chemists already established by the Chemical Society.

A joint meeting of the Washington Junior Academy of Sciences and the local Science Clubs is to be held on November 21, 1953, at the National Museum under the direction of Miss MARGARET PATTERSON, Executive Secretary of Science Clubs of America.

Societies and individuals interested in the promotion of science talent are invited to send contributions for the Eighth Washington Science Fair to HOWARD S. RAPPELEYE, Treasurer of the Academy.

The Secretary reported the result of the ballot vote on the application of the Washington Section, Institute of the Aeronautical Sciences for affiliation with the Academy. A total of 193 votes were cast, of which 190 were for affiliation and 3 against. DR. R. J. SEEGER, nominated by the Washington Section of the IAS for Vice-President of the Academy was elected.

The deaths of the following members of the Academy were announced: JOHN R. MOHLER, February 28, 1952; GEORGE R. PUTNAM, July 2, 1953; FREDERICK E. WRIGHT, August 25, 1953; and EDWARD B. VEDDER, January 1951.

MR. RAPPLEYE presented the resignation of O. S. AAMODT and S. F. SNIESZKO which were accepted, that of DR. AAMODT effective December 31, 1952, and DR. SNIESZKO effective December 31, 1953.

Payment of insurance on shipments of reprints by the Academy rather than by the authors was approved by the Board.

MR. RAPPLEYE reported that six contributions to the Science Fair, amounting to $150, had been received to date from affiliated scoieties.

DR. REHDER presented data and plans for advertising the Index to the Journal. The estimated cost was about $600. The Board approved the expenditure of this amount for the purpose.

The Secretary read a communication from the Academy Conference of the A.A.A.S., requesting a contribution from the Academy at the rate of $1 for each 100 members, to defray office expenses of the Conference. A contribution of $9 was approved by the Board.

DR. ALLEN V. ASTIN presented to the Academy the report of the ad hoc Committee for Evaluation of the Present Functions and Operations of the National Bureau of Standards, and a Report of the Committee on Battery Additives of the National Academy of Sciences. He also expressed his appreciation for the action taken by the Academy.

JASON R. SWALLEN, *Secretary*